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Facilities which manage hazardous wastes are required to obtain permits under the Resource Conservation and Recovery Act (RCRA) of 1976. This guidance document informs RCRA permit writers and enforcement officials of procedures to be used in conducting RCRA Facility Assessments. The RCRA Facility Assessment is the first step of the corrective action process authorized by Sections 3004(u), 3004(v), and 3008(h) of RCRA as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

The RCRA corrective action program was established to investigate and require clean up of releases of hazardous wastes or constituents to the environment at facilities subject to RCRA permits. Releases to ground water, surface water, air, soil, and subsurface strata may be addressed. Contamination from RCRA facilities which has migrated beyond the facility boundary may also be addressed. When facilities not being reviewed immediately for issuance of a permit are found to have releases of concern, the releases may be addressed through the enforcement authority of Section 3008(h).

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RCRA FACILITY ASSESSMENT GUIDANCE

Permits and State Programs Division
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CHAPTER ONE

INTRODUCTION

I. OBJECTIVES AND SCOPE OF THE RCRA CORRECTIVE ACTION PROGRAM

The primary objective of the RCRA corrective action program is to clean up releases of hazardous waste or hazardous constituents that threaten human health or the environment. The program applies to all operating, closed or closing RCRA facilities.

The 1984 Hazardous and Solid Waste Amendments (HSWA) established broad new authorities in the RCRA program to assist EPA in accomplishing these objectives. These new authorities are:

- §3004(u) - Corrective Action for Continuing Releases

  Requires that any permit issued after November 8, 1984, require corrective action for all releases from solid waste management units at the facility. The provision also requires that owner/operators demonstrate financial assurance for any required corrective action, and allows schedules of compliance to be used in permits where the corrective action cannot be completed prior to permit issuance.

  §3008(h) - Interim Status Corrective Action Orders

  Provides authority to issue enforcement orders to compel corrective action or other response measures at interim status facilities, and to take civil action against facilities for appropriate relief.

  §3004(v) - Corrective Action Beyond the Facility Boundary

  Directs EPA to issue regulations requiring corrective action beyond the facility boundary where necessary to protect human health and the environment, unless the owner/operator can demonstrate that he is unable to obtain the necessary permission, despite his best efforts. Until such regulations are promulgated, corrective action orders can be issued to require the necessary corrective action.

These authorities change the focus of the RCRA corrective action program from detecting and correcting future releases from regulated units to cleaning up problems resulting from past waste management practices at RCRA facilities. Prior to passage of the HSWA, EPA's authority to require corrective action for releases of hazardous constituents under RCRA was limited to ground water releases from units that were covered by RCRA permits. Part 264, Subpart F provided the vehicle for requiring corrective action at these "regulated units". The post-HSWA program extends RCRA authority to releases to all media and all units at RCRA facilities and encourages the use of other authorities, as needed or appropriate, to help achieve corrective action objectives at these facilities.

The RCRA corrective action program consists of three phases:

1. The RCRA Facility Assessment (RFA) to identify releases or potential releases requiring further investigation.
2. The RCRA Facility Investigation (RFI) to fully characterize the extent of releases.
3. Corrective Measures (CM) to determine the need for and extent of remedial measures. This step includes the selection and implementation of appropriate remedies for all problems identified.

This guidance document describes the first phase of this process and outlines procedures and criteria EPA and State personnel should follow in conducting RFAs at RCRA facilities.

II. PURPOSE OF THE RFA

The RCRA Facility Assessment is a three-stage process for:

- o Identifying and gathering information on releases at RCRA facilities;
- o Evaluating solid waste management units (SWMUs) and other areas of concern for releases to all media and regulated units for releases to media other than ground water;
- o Making preliminary determinations regarding releases of concern and the need for further actions and interim measures at the facility; and
- o Screening from further investigation those SWMUs which do not pose a threat to human health or the environment.

During the RFA, EPA or State investigators will gather information on SWMUs and other areas of concern at RCRA facilities. They will evaluate this information to determine whether there are releases that warrant further investigation or other action at these facilities. Upon completion of the RFA, Agency personnel should have sufficient information to determine the need to proceed to the second phase (RFI) of the process.

All three steps of the RFA require the collection and analysis of data to support initial release determinations:

- The preliminary review (PR) focuses primarily on evaluating existing information, such as inspection reports, permit applications, historical monitoring data, and interviews with State personnel who are familiar with the facility.

- The visual site inspection (VSI) entails the on-site collection of visual information to obtain additional evidence of release.

- The sampling visit (SV) fills data gaps that remain upon completion of the PR and VSI by obtaining sampling and field data.

III. SCOPE OF THE RFA

This section addresses:

- Releases covered in the RFA;

- Relation of the RFA to the CERCLA PA/SI;

- The extent and role of sampling in the RFA; and

- Roles and responsibilities.

Releases Covered in the RFA

The RFA should identify all areas of potential release at RCRA facilities and include the investigation of releases to all media: air, surface water, ground water, and soils. However, ground water releases from regulated units are not addressed in the RFA. EPA and/or State investigators should use the full complement of RCRA authorities to secure appropriate action. These include §3004(u), §3008(h), §3004(v), §3013 and §7003. If these authorities are not sufficient to compel the desired action, Agency investigators may wish to use other authorities, such as CERCLA §106 or TSCA §7 authorities and should consult with EPA or State offices responsible for administering these programs.

The HSWA §3004(u) provision focuses on investigating releases from SWMUs at RCRA facilities. Solid waste management units are defined as:

- Any discernible waste management unit at a RCRA facility from which hazardous constituents might migrate, irrespective of whether the unit was intended for the management of solid and/or hazardous waste.

The SWMU definition includes:

- Containers, tanks, surface impoundments, waste piles, land treatment units, landfills, incinerators, and underground injection wells, including those units defined as "regulated units" under RCRA.

- o Recycling units, wastewater treatment units and other units which EPA has generally exempted from standards applicable to hazardous waste management units.
- o Areas contaminated by "routine, systematic, and deliberate discharges" from process areas.

The definition does not include accidental spills from production areas and units in which wastes have not been managed (e.g., product storage areas).

The RFA will not routinely address releases that are permitted or required to be permitted under other environmental programs or contamination resulting from permitted discharges. Where such discharges are of concern, RCRA personnel should refer the case to the original permitting authority. If that authority does not take appropriate action, EPA can exercise its authority under §3004(u), §3004(v), §3008(h) or §3013. Where the RFA identifies contamination requiring further investigation, RCRA staff should work on a case-by-case basis with the Regions and other EPA permit programs to develop a solution to the contamination problem.

The RFA does address releases from SWMUs to media other than the one covered by the unit's discharge permit. For example, EPA can use §3004(u) or §3008(h) to control the release of volatile organic compounds from NPDES-permitted wastewater treatment units where there is cause for concern.

Relation of the RFA to the CERCLA PA/SI

The CERCLA PA/SI and the RFA differ in two important respects. First, the CERCLA PA/SI focuses on the potential for offsite exposures from releases, while the RFA focuses on identifying specific releases at RCRA facilities and considers the potential for offsite exposures primarily in determining whether to require interim corrective measures.

Second, the CERCLA PA/SI was developed primarily as a method for scoring facilities to determine whether they should be on the CERCLA National Priority List (NPL). The RFA does not formally rank or prioritize facilities. The RCRA program may use the facility management planning (FMP) process to establish State and Regional priorities at and among RCRA facilities. The FMPs provide a framework for determining specific permitting and enforcement actions that should be taken at a facility and which facilities EPA should address first. Information on potential releases at a facility is an important input into this process. However, it is evaluated along with other information on the facility's compliance and permitting status to establish overall program priorities.

Extent and Role of Sampling

EPA purposely designed the RFA to be limited in scope. This guidance establishes a framework to assist EPA investigators in making preliminary release determinations that are largely based on existing information and best professional judgment. The framework emphasizes the need to focus data collection and analysis efforts (i.e., sampling data) on those data that are required to support specific permit or enforcement order conditions. In general, the stronger the case that the investigator must make to compel an owner/operator to conduct an RFI or to convince the public that a SWMU does not pose a threat, the greater the amount of information he/she will need to collect in the SV.

The Agency recognizes that sampling needs will differ on a case-by-case basis. The extent of sampling will depend on the amount and quality of information gathered in the PR and VSI, the investigator's professional judgment regarding the amount of information necessary to support an initial release determination, and the degree of owner/operator cooperation.

Responsibility for Conducting the RFA

As the program is currently set up, EPA and/or the States are responsible for conducting RFAs. Because of the subjective nature of these investigations, the Agency believes that it is appropriate for a regulatory agency to conduct the RFAs. These initial release determinations will provide the basis for requiring a number of potential follow-on activities ranging in scope from no further action to a full corrective action program. EPA and the States may use contractors to assist them in conducting these investigations, but the regulatory agency retains overall responsibility for the RFA decisions.

In some instances, it may be appropriate for the facility owner/operator to perform certain sampling activities. EPA and/or the State should make such determinations on a case-by-case basis and should carefully review and approve plans developed by owner/operators and oversee field activities conducted by the owner/operator.

IV. TECHNICAL APPROACH

All three steps of the RFA require the investigator to examine extensive data on the facility and specific units at the facility. These data can generally be divided into five categories:

- o Unit characteristics;
- o Waste characteristics;
- o Pollutant migration pathways;

- Evidence of release; and

- Exposure potential.

Exhibit 1-1 provides a matrix of these categories and the specific factors that investigators need to consider in each category. The investigator will need to apply his/her best professional judgment in examining these factors, how they interact, and their effects on the likelihood of a release and its significance.

Exhibit 1-2 outlines the types of information in each category that investigators are likely to obtain during each of the three steps in the RFA. In general, during the PR, the investigator will examine documents and other written materials to obtain information on the facility's location, potential environmental receptors, characteristics of the waste handled at the facility as a whole and managed in SWMUs, the design and operating features of the SWMUs themselves, and evidence of past releases. This information will assist the investigator in determining which media and migration pathways are of concern and why. The investigator will supplement this information with additional evidence gathered during the VSI and samples taken during the SV.

Specific factors in each category that must be considered will vary depending on which medium is of concern. For example, land-based units are more likely to have ground-water releases than aboveground units; surface impoundments are more likely to have air releases than landfills. Certain wastes tend to volatilize and cause air releases, while other wastes are soluble in water and tend to migrate via surface or ground water. A facility's location will determine which media are of concern. Surface water releases should not be a concern for facilities that are not located near surface water. Types of evidence and potential receptors will also vary by media.

Each of the media-specific chapters describes the factors in each of the five categories that investigators should examine for the media of concern. Each chapter is organized to follow the three steps of the RFA and is designed to assist the investigator in identifying releases for each of the media of concern.

The RFA is completed when the investigator has sufficient information to make a determination regarding releases or likely releases at the facility and the need for further investigations. Sometimes it will be possible to make this determination after completing the first two steps (the PR and VSI), and a SV will not be necessary. In other cases, even upon completion of the SV, the investigator may need to perform additional follow-up inspections or collect further sampling or other information from the owner/operator before making this determination.

In general, when the RFA is completed, the investigator will have:

EXHIBIT 1-1

MAJOR FACTORS TO CONSIDER IN CONDUCTING RFAs

Unit Characteristics	Waste Characteristics	Migration Pathways	Evidence of Release	Exposure Potential
type of unit design features operating practices (past and present) period of operation age of unit location of unit general physical conditions method used to close the unit	type of waste place in the unit migration and dispersal characteristics of the waste toxicological characteristics physical and chemical characteristics	facility's geologic setting facility's hydrogeologic setting atmospheric conditions topographic characteristics	prior inspection reports citizen complaints monitoring data visual evidence e.g., discolored soil, seepage, discolored surface water or runoff. other physical evidence, e.g., fish kills, worker illness, odors sampling data	proximity to affected population proximity to sensitive environments likelihood of migration to potential receptors

Exhibit 1-2

TYPES OF INFORMATION EVALUATED DURING THE THREE STEPS OF THE RFA

RFA STEP	UNIT CHARACTERISTICS	WASTE CHARACTERISTICS	MIGRATION PATHWAYS	EVIDENCE OF RELEASE	EXPOSURE POTENTIAL
PRELIMINARY REVIEW	Evaluate information on design, liners, age, construction, location, method of closure.	Review historical information on types, volumes, characteristics of wastes handled.	Review site hydrogeology, surface water runoff pathways, prevailing winds, locations of rivers, etc.	Review historical sampling data, reports of release, citizen complaints, etc.	Locate drinking water wells, uses of nearby surface water, potential for subsurface gas migration, etc.
VISUAL SITE INSPECTION	Review general unit conditions. Look for evidence of unit failure, problematic operating practices, subsidence and/or ponding at closed units.	Review waste management practices.	Observe erosion indicating runoff, likely pathways of release to each medium from units, etc.	Obtain visual evidence of releases, e.g., seeps, dead vegetation, discolored soils and sediments, etc.	Collect visual evidence on potential exposure of sensitive environments or humans.
SAMPLING VISIT	May observe additional evidence.	Characterize waste through sampling and analysis.	Sample pathways for additional evidence of release.	Sample pathways, wastes for specific constituents.	Sample for hazardous constituents in wells, high concentrations of volatile organics.

- Identified all potential releases of concern;
- Identified all SWMUs;
- Determined which areas need further investigation and and collected sufficient information to focus these investigations;
- Determined which areas require interim measures;
- Screened out releases that do not require any further investigation; and
- Referred permitted releases to other authorities, as appropriate.

Upon completion of the RFA, the investigator prepares a report summarizing his/her findings. The report should integrate the findings from all three steps in the RFA and include a description of the facility and its waste management practices, release information for all SWMUs or groups of SWMUs and other areas of concern, sampling plan and results, and final release determinations and recommendations. This report should clearly indicate those areas of the facility that require further investigation in a RFI and should contain information to focus these investigations. A sample outline of an RFA report is presented in Appendix A.

Conducting an RFA can present an opportunity to gather information on a facility which may be useful for purposes other than making RFA determinations. Regions or States may choose, for example, to collect certain data on facility characteristics and other site-specific environmental data as a means of establishing programmatic priorities for corrective action. Appendix F provides a listing of some example data elements which could be used for such purposes.

V. ORGANIZATION OF THIS DOCUMENT

This document contains nine chapters. The second chapter describes the PR process, the third chapter describes the VSI, and the fourth chapter explains the SV. In addition, there are five technical chapters that apply the technical approach outlined in chapters two, three and four to the various media of concern: ground water, surface water, air, subsurface gas and soil.

CHAPTER TWO

CONDUCTING A PRELIMINARY REVIEW

I. INTRODUCTION

A. Purpose

This chapter describes how to conduct a preliminary review (PR), the first step in the RCRA Facility Assessment (RFA) process for identifying releases or potential releases at RCRA facilities under the RCRA corrective action requirements. The PR serves two primary purposes:

(1) To gather and evaluate existing information on facilities in order to identify and characterize potential releases; and

(2) To focus the activities to be conducted in the second and third steps of the RFA, the visual site inspection (VSI) and the sampling visit (SV).

B. Scope

During the PR, EPA personnel will evaluate existing documents and speak with relevant individuals (e.g., RCRA inspectors, State and Federal permitting staff, etc.) in order to identify areas at a facility which may be releasing hazardous wastes or hazardous constituents posing a potential threat to human health and the environment. The PR will consider information on the entire facility, and will not be limited to collecting and evaluating information covering the RCRA-regulated areas at the facility. In particular, the investigator will identify and gather information on SWMUs and other areas where wastes have been managed at the facility.

While the scope of the PR will focus on identifying and evaluating releases resulting from waste management activities, the investigator should consider documents he/she finds which provide information on releases at the facility which may be beyond the scope of the RCRA corrective action authorities. These could include releases subject to investigation and remediation under CERCLA or TSCA authorities.

The scope of the PR includes investigating release potential to all environmental media at the facility (with the exception of ground-water releases from regulated units):

- o Ground water;
- o Surface water;
- o Air;
- o Soils; and
- o Subsurface (gas).

At complex facilities with many SWMUs, it may be more practical to evaluate groups of similarly located or designed SWMUs rather than characterizing each unit separately. Additionally, investigators should not focus solely on releases from SWMUs, but should examine the full facility for evidence of spills and/or other releases resulting from waste management activities which may not fit the definition of a SWMU release (see definition of a SWMU on page 1-4).

This chapter describes how to conduct a PR at RCRA facilities by:

(1) Collecting PR information;

(2) Evaluating PR information; and

(3) Completing the PR.

C. Product

At the end of the PR, the investigator will summarize the findings of the PR. He/she should document the information sources evaluated, describe the potential releases of concern identified at the facility (especially all SWMUs), and make recommendations that will focus subsequent activities in the VSI and the SV. The results of the PR will serve as the foundation of the RFA report, which will be revised at the end of the VSI and finalized following the SV. A sample outline for an RFA report is included as Appendix A.

II. GATHERING PR INFORMATION

The first step in the PR involves collecting information on a facility that will provide evidence of its potential for release. The success of the PR will depend to a great extent on the investigator's ability to collect relevant information. A PR may provide misleading results when significant sources of information are not considered (e.g., enforcement documents describing known releases, relevant sampling or monitoring data, etc.). EPA should plan each PR to ensure that all relevant sources of information pertaining to a facility are examined. Gathering data in the PR will usually involve:

(1) Collecting documents and other written reports;

(2) Meeting with relevant individuals; and

(3) Collecting additional information from the owner/operator.

The PR focuses on evaluating information in the five basic categories presented in the RFA information matrix (Exhibit 1-1).

The matrix illustrates the types of information in each category (unit characteristics, waste characteristics, pollutant migration pathways, evidence of release, and exposure potential) which should be evaluated during the PR. It should be noted, however, that it is difficult to obtain complete data for any of the five categories during the PR, and that the VSI and SV will provide additional opportunities to collect information during the RFA.

A. Written Information and Documents

This section briefly summarizes those data sources which have been found to be most useful in conducting PRs to date. A detailed discussion of all potentially relevant data sources is included as Appendix B to this document.

Four basic RCRA file sources and several additional RCRA documents typically contain the most useful information during the PR:

(1) RCRA permit applications;

(2) Facility SWMU response (RSI #3);

(3) RCRA inspection reports;

(4) RCRA exposure information reports; and

(5) Additional RCRA sources.

Brief discussions on each of these sources follow.

1. Permit Applications

Part A and B permit applications or closure plans are available for all facilities in the permit pipeline and addressed under the corrective action program.[1] Although owner/operators develop these applications to support permitting or closure of regulated units, they will usually contain information on other areas of the facility relevant to the RFA.

Part A permit applications provide information on the wastes being treated, stored, and/or disposed in the regulated units at a facility. These forms can be useful in identifying the wastes of concern at the facility, although it should be noted that the wastes disposed in old SWMUs may have different characteristics than those currently disposed in regulated units, due to changes in facility production processes or changes of ownership. The Part A will often provide a scale drawing showing the location of all past treatment, storage, and disposal areas (§270.13(h)), which can be useful in identifying SWMUs and other areas of concern.

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[1] The proposed Codification Rule of March 28, 1986 incorporates RSI #3 information (described above) into permit application requirements.

A land disposal Part B permit application provides extensive hydrogeologic information related to the surficial aquifer at a facility, including a description of the facility's ground-water monitoring system. This information is useful for identifying ground-water pollutant migration pathways and prior releases from SWMUs at land disposal facilities. However, this information is not likely to be available for storage and treatment facilities.

2. SWMU Response (RSI #3 Submission)

The Reauthorization Statutory Interpretation (RSI #3) issued by EPA Headquarters required the EPA Regional Offices to request owner/operators of RCRA facilities to submit data on each SWMU at their facilities. The data owner/operators submitted in response to this request is usually helpful for identifying SWMUs at a facility. However, many submissions have been found deficient, and RCRA investigators should not assume that these submissions accurately identify all of a facility's SWMUs. Other sources, such as compliance inspection reports and the VSI should be used to verify and augment the information contained in the SWMU response.

3. Compliance Inspection Reports/Information from Enforcment Orders

RCRA inspection reports will often provide extensive information on facility waste generation and handling practices, old and new waste management units, and prior releases at the facility. They may also describe migration pathways and exposure points.

4. Exposure Information Report

Only facilities seeking permits for landfills and surface impoundments are required to submit exposure information. These submissions provide information on all five categories in the RFA information matrix (Exhibit 1-1). These reports can be useful in identifying pollutant migration pathways from the facility to potential exposure points, and may also discuss the likelihood of human exposure to hazardous constituents.

5. Additional RCRA Sources

- Biennial Report (§265.75) -- The biennial report, prepared by the owner/operator and submitted to the Regional Administrator, provides a description and the quantities of each hazardous waste received during the previous year, and the method of treatment, storage, or disposal for each waste.

- Operating Log (§265.73) -- The facility operating log provides a map displaying the location and quantities of wastes disposed throughout the facility. It also provides reports of all incidents that required implementation of the Facility Contingency Plan.

- RCRA Waste Manifest (§265.71) -- The manifest will provide details on all wastes received at the facility after November 18, 1980. Facilities are only required however, to retain manifest for three years.
- Notice to Local Authority (§265.14) -- The owner/operator, within 90 days after closure of a disposal unit, must submit to the local land authority and the Region records of the locations and quantities of wastes within a closed unit. The owner/operator must also provide descriptions of the types, locations, and quantities of wastes in units closed before promulgation of the Part 265 regulations.

6. Other Sources

Many other sources can provide useful information for evaluating the likelihood of releases at a facility. After the RCRA sources outlined above, these are likely to contain the most valuable information:

- NPDES and CAA permits and permit applications;
- CERCLA PA/SI Reports;
- Installation Restoration Program (IRP) Reports;
- HRS Documentation;
- CERCLA RI/FS Studies;
- CERCLA 103(c) Notifications;
- Aerial Photographs;
- Other Federal/State Agencies; and
- TSCA/OSHA/NPDES Inspections.

A number of other sources may also provide some useful information, although they will be needed less often:

- GEMS (Graphical Exposure Modeling System);
- State/Local Well Permit Offices;
- Municipal/County/City Public Health Agencies;
- Local Well Drillers;
- State/County Road Commissions;
- Utilities;
- Local Airports/Weather Bureaus;
- Naturalists/Environmental Organizations;
- Facility Employees;
- Colleges/Universities; and
- Interviews with Local Residents.

It will not be necessary to look at each of these sources in all situations, but they can be examined as appropriate to help fill information gaps. All the data sources listed above are described more fully in Appendix B.

B. Meeting with Relevant Individuals

It will be useful to meet with personnel from State agencies and other EPA program offices (e.g., NPDES permitting program) in the initial stages of the PR. Other EPA permitting programs may have considerable historical knowledge of a facility, including information on SWMU releases, instances of non-compliance, facility waste generation practices, and inspection reports. Early contact with these groups can help ensure that all relevant information is considered during the PR.

C. Collecting Additional Information

In situations where the investigator does not find sufficient information concerning the location or characteristics of a facility's SWMUs to complete a PR, it may be necessary to request additional information from the owner/operator. Such requests should be in the form of a letter in which EPA requests additional information from the facility in order to comply with the HSWA corrective action requirements. Where necessary, EPA should cite its §3007 information gathering authority to obtain this information. These letters should be as specific as possible to ensure that the requested information is submitted in a timely manner. A sample letter is included as Appendix C.

III. EVALUATING PR INFORMATION

The PR focuses on evaluating the information gathered during its initial stages. This section presents a framework for evaluating PR information in order to gain an understanding of the facility's release potential. This will involve three basic steps:

(1) Investigating the facility's waste generation processes;

(2) Identifying SWMUs and other potential releases of concern; and

(3) Evaluating the facility's release potential.

A. Investigating Facility Waste Generation Processes

It will be important to understand the facility's overall waste generation and management activities, both past and present, when evaluating how SWMUs and other areas of the facility have been used to handle wastes and how they relate to the facility's overall waste management system. Whenever possible, the investigator should determine what types of waste have been managed at the facility since it began operation in order to identify potential constituents of concern.

As discussed in Section II of this chapter, RCRA compliance inspection reports may provide a useful source of information on manufacturing processes, as will some NPDES permit applications. In some cases, inspection reports may also discuss where wastes from previous manufacturing processes have been disposed at a facility or may include information on past releases.

The following example illustrates the benefits of investigating a facility's waste generation processes. A secondary lead smelting facility closed several surface impoundments that were orginally part of an NPDES wastewater treatment process. The impoundments were clean closed by excavating to a depth determined by the concentration of lead in the soil. The facility stated that lead was the only constituent of concern in these units. During the PR, EPA investigated the facility's production processes and found that several other metals such as cadmium, nickel, antimony, and barium might be mixed with the lead wastes. Based on this information, EPA took soil samples for each of these other constituents of concern.

B. Identifying SWMUs and Other Potential Releases of Concern

Once the investigator has gained an understanding of the facility's overall waste generation and management activities, he/she should locate all areas with potential releases of concern on a map of the facility. The map should include all SWMUs identified in the RSI #3 SWMU response, SWMUs described in other documents, and other potential releases of concern, e.g., spills of hazardous waste or constituents from waste management activities. In addition, the investigator should locate on the facility map other potential releases of concern which may be beyond the scope of the RCRA authorities.

The facility map will be an extremely useful document throughout the RFA, especially when conducting the VSI and the SV. In addition to locating SWMUs, it will often be possible to identify relevant migration pathways and potential exposure points (e.g., rivers and nearby housing) on this map. Additional releases of concern can be added to the map when identified at later stages in the RFA, particularly the VSI.

As discussed in the Introduction, the definition of a SWMU includes recycling units, wastewater treatment units (such as those regulated under NPDES), and other units which EPA has generally exempted from RCRA permitting standards. Each of these units identified at a facility should be located on the facility map as a SWMU. Regulated land disposal units are also treated as SWMUs, since they will be investigated for releases to media other than ground water in the RFA.

Several information sources will be especially useful when identifying SWMUs and other releases of concern in addition to the RSI #3 submission. Historical aerial photographs, such as those available from EMSL or EPIC, may reveal the presence of past waste management areas which have become overgrown or otherwise hidden. In some cases, closed landfills and surface impoundments cannot be distinguished from ordinary open fields and historical aerial photographs can help identify these units. Appendix B provides a more detailed discussion on obtaining and evaluating aerial photographs.

C. Evaluating the Facility's Release Potential

Once the investigator has identified potential releases of concern at the facility, he/she should determine the likelihood of release at each location by evaluating information gathered in the initial steps of the PR. It will seldom be possible to determine from one document that a SWMU has released hazardous wastes or constituents. In most cases, the investigator will have to deduce the likelihood that a release of concern has occurred by evaluating information from numerous sources covering the five categories of information presented in Exhibit 1-1: unit characteristics, waste characteristics, pollutant migration pathways, evidence of release, and exposure potential.

The evaluation requires the investigator to seek evidence that a unit has released or is likely to have released. The investigator should make deductions based on various amounts of information on the wastes contained within a unit, the design/operating characteristics of the unit, and the presence of contaminants in any of the pollutant migration pathways associated with the unit.

In some cases, the investigator may have actual evidence that a unit released to a particular medium. In other situations, it may be necessary to draw connections between a constituent identified in a unit, the likelihood that this constituent could have been released from the unit, and sampling data showing the presence of the constituent in a migration pathway. While this deduction may not prove unequivocally that the constituent identified in the environment originated in the suspected unit, such deductions will usually be sufficient to identify a release of concern in the RFA.

The investigator's ability to make deductions on the likelihood of release will depend on the extent of information he/she collects pertaining to the first four items in the RFA information matrix: unit characteristics, waste characteristics, pollutant migration pathways, and evidence of release. Information on exposure potential is not needed to determine the likelihood of release, but is important in determining the need for interim corrective measures due to immediate exposure risks. The kinds of information to be considered in each of these five categories are described below.

1. Unit Characteristics

The design and operating characteristics of a SWMU will determine to a great extent its potential for release. Many treatment, storage, and disposal units are designed to prevent releases to the environment. The investigator should evaluate the physical characteristics of each SWMU or group of SWMUs to determine how they affect the potential for releases.

The media-specific chapters in this guidance provide detailed discussions of how the design and operating characteristics of various types of SWMUs affect their potential for releasing to each medium. For example, surface impoundments with well-designed, intact berms for controlling overtopping do not exhibit a high potential for surface water releases. EPA assumes, however, that unlined surface impoundments have a high potential for releasing constituents to ground water. Surface impoundments which contain volatile organic compounds also exhibit a high potential for air releases. The investigator should examine the characteristics of each SWMU based upon the discussions presented in Chapters Five through Nine in order to consider the likelihood of release to each of the environmental media: ground water, surface water, air, soils, and subsurface (gas). Investigators will often find situations where unit design characteristics suggest that a SWMU poses little or no threat to the environment from releases (e.g., intact above-ground storage tanks).

2. Waste Characteristics

In evaluating a SWMU's release potential, the investigator should identify the wastes originally or currently contained in the unit in order to link constituents observed in the environment with those present in the contaminant source. The investigator can usually deduce that a release has occurred when he/she determines that a SWMU contained a constituent that has been observed in a pollutant migration pathway associated with that unit.

The information gathered while investigating the waste generation processes at a facility will provide the basis for this part of the PR. In many cases, a facility will indicate how it managed many of its waste streams, e.g., off-site shipment, disposal in a specific surface impoundment, or storage in a waste pile. When a particular waste stream can be traced to a particular unit, the investigator can generally assume all of the constituents present in that waste stream are also present in the unit.

The information gathered on facility waste generation processes may often be useful in identifying constituents other than listed constituents of concern to RCRA. For example, rapidly decomposable refuse may produce methane when placed in landfills under certain conditions.

The investigator should identify all of the hazardous constituents which may be present in each SWMU or other areas of concern. Some constituents will have a greater potential for release from one kind of SWMU than another. For example, the air chapter discusses the likelihood that volatile organic constituents will be released from wastewater treatment units. The media-specific chapters discuss the ways in which constituent properties can affect the likelihood of releases to various media.

3. Pollutant Migration Pathway

The investigator should evaluate existing information concerning the likely pollutant migration pathways associated with each SWMU or release of concern. In cases involving environmental data, the investigator will have to demonstrate that it is reasonable to deduce that a constituent observed in the environment originated at a specific SWMU or location, based upon knowledge of the pollutant migration pathway.

While some pollutant migration pathways are largely facility-wide (e.g., ground water), the investigator should evaluate the importance of all pollutant migration pathways (i.e., ground water, surface water, air, soils, and subsurface gas) that could be associated with each SWMU and then evaluate information on their characteristics. SWMUs which contain the same wastes and are adjacent to each other may be grouped together during the RFA. It will often be possible to eliminate certain pathways from consideration for various SWMUs at this point in the PR.

Different types of SWMUs will exhibit different potentials for releasing constituents to specific migration pathways. The investigator should determine which SWMUs are likely to impact which pollutant migration pathways at the facility, and gather specific information that will aid in determining the characteristics of these pathways. This part of the analysis also provides a critical role in identifying potential exposure points along various migration pathways, which is important in evaluating exposure potential for interim measures at the facility.

The media-specific chapters provide information to aid the investigator in evaluating the physical characteristics of each migration pathway of interest. The investigator should consider:

- Potential routes of pollutant transport;
- Physical factors within the pathway that could affect the migration of constituents (e.g., organic content of soil for releases to soil and ground water, or prevailing wind patterns for air releases); and
- Other factors which could affect the fate of constituents present in a migration pathway.

4. Evidence of Release

The investigator should examine available sources of information to identify any evidence that constituents have been released at a facility. The investigator may have access to direct and indirect evidence of release, both of which may help in making determinations of release at a facility.

Direct evidence of release includes official reports of prior release incidents (which may be found in RCRA enforcement or permitting documents, other Federal, State, or local government documents, facility records, RSI #3 responses, etc.), visual evidence clearly showing a release incident, or sampling data that clearly identifies a releasing SWMU (e.g., surface water samples for a specific constituent in a clear run-off pathway).

Indirect evidence of release includes sampling data taken along relevant migration pathways which, when linked together with waste composition data, can support a deduction concerning the likelihood of release from a specific unit at the facility.

The VSI, which is described in Chapter Three, is generally an excellent source of both direct and indirect evidence on releases. Stained soils in a well-defined drainage pathway below a unit can provide direct evidence of release; stressed vegetation may provide indirect evidence of release.

The media-specific chapters describe the types of evidence that are important for releases to each of the environmental media. For example, visual sightings of seepage along a stream bank provide evidence of both a ground-water release and a surface water release. The investigator should refer to the section on evidence of release in each of the media-specific chapters. In all cases, the investigator should use best professional judgment in assessing the strength of any information source in providing evidence of release.

5. Exposure Potential

The investigator should evaluate available information on the location, number, and characteristics of receptors that could be affected by continuing releases at the facility. These receptors include human populations, animal populations (particularly any endangered or protected species), and sensitive environments. This information will be most useful in helping the investigator determine the need for interim corrective measures at the facility to alleviate especially high risks of exposure. The investigator should refer to the RCRA §3008(h) Corrective Action Orders Interim Measures Guidance for details on when and how to implement interim measures.

The media-specific chapters provide information on what receptors are likely to be affected by releases to each of the media.

IV. COMPLETING THE PRELIMINARY REVIEW

The investigator's ability to determine that a release may pose a threat to human health or the environment will increase with the quantity and quality of information gathered in the RFA. By the end of the PR, the investigator will usually have identified many of the potential releases of concern at the facility, and will have made a preliminary evaluation concerning the likelihood that a release of concern has occurred at each SWMU, group of SWMUs, or other potential areas of concern.

The next phase of the RFA, the VSI, provides additional evidence to help the investigator determine which units or areas of concern require: additional investigation in a sampling visit, interim measures, further investigation in an RFI, or no further action. The investigator will usually consider the following factors before proceeding with the VSI: 1) identifying significant data gaps, 2) focusing the next two steps of the RFA, and 3) beginning the RFA report.

A. Identifying Significant Data Gaps

Depending upon the quality of information gathered during the PR, the investigator may have a strong idea concerning the likelihood of releases from SWMUs or other areas of concern identified in the PR. In many cases, however, the investigator will be missing important information on a potential release or unit of concern (e.g., information on the wastes handled within the unit).

In such cases, it may be necessary to make a formal request for additional information from the owner/operator. As stated earlier, investigators may need to cite the RCRA §3007 information authority when making this request. The letter should be extremely specific in order to ensure that the owner/operator clearly understands what information has been requested (see Appendix C).

B. Focusing the Visual Site Inspection and Sampling Visit

One of the primary purposes of the PR is to provide the investigator with an understanding of the waste management activities at the facility, enabling him/her to focus subsequent observations in the VSI and the SV to the greatest extent possible. Because all facilities will undergo a PR and a VSI, emphasis will be placed on the quality of the information gathered in these two stages. If the conclusions drawn from a PR and VSI are not based upon sufficient information, it is likely that owner/operators or the public will challenge permit conditions or enforcement orders developed to compel further actions at the facility.

The investigator should evaluate the information gathered in the PR on each SWMU or potential release of concern, and determine whether: 1) it is likely that the unit has released, 2) it is unlikely that the unit has released, 3) there is insufficient evidence at this stage to assess the likelihood of release, or 4) a release could threaten human health or the environment. The VSI will provide more useful information if the investigator conducts it with these preliminary determinations in mind. While it is too early to draw conclusions at the end of the PR, it will often be possible to screen out units from further consideration at the end of the VSI. During the PR, the investigator may identify units that are not likely to have releases of concern. These units should be inspected carefully in the VSI before determining that they need no further investigation or action.

The investigator can also make preliminary recommendations concerning the need for collecting additional sampling data in an SV. It will often be possible to identify units or locations where sampling data can help in making determinations of release.

Recommendations on sampling locations made in the PR should be checked for appropriateness during the VSI. In general, the VSI and SV should provide the additional information needed to fill data gaps identified during the PR.

C. Documenting the Preliminary Review

The investigator should document the findings of the PR by beginning the RFA report, which will summarize the complete RFA process. The investigator will incorporate the results of each step of the RFA into this report, resulting in a complete document providing recommendations concerning: 1) the need for an RFI at the facility, 2) the need for interim measures at the facility, or 3) the need for no further action at the unit/facility at this time.

At the end of the PR, the report should document information sources, identify SWMUs and other areas of potential release on a facility map, and contain preliminary evaluations of the likelihood of release at each locations. This information will be used throughout both the VSI and the SV.

A sample outline of an RFA report is included as Appendix A.

CHAPTER THREE

CONDUCTING A VISUAL SITE INSPECTION

I. INTRODUCTION

A. Purpose

The visual site inspection (VSI) is the second step of the three-step RFA process for identifying releases at RCRA facilities in the corrective action program. The VSI will focus on identifying SWMUs and collecting visual evidence of release at facilities to assist EPA in recommending further steps in the corrective action process. The major purposes of the VSI include:

(1) Visually inspecting the entire facility for evidence that releases of hazardous wastes or constituents have occurred and identifying additional areas of concern;

(2) Ensuring that all SWMUs and areas of concern have been identified;

(3) Filling data gaps identified in the PR; and

(4) Focusing recommendations concerning the need for a sampling visit, interim measures, an RFI, or no further action at a facility.

By the end of the VSI, the investigator will be able to determine at which locations it will be necessary to collect additional environmental samples in a sampling visit (SV). In some cases, it will be possible to screen a unit from further investigation or to recommend further investigation in an RFI without conducting additional sampling, thus completing the RFA.

B. Scope

The VSI will include the entire RCRA facility and can extend beyond the property boundary in certain cases. The VSI should focus on inspecting the discernible SWMUs at the facility. However, the investigator may inspect areas outside the facility boundary to determine if a release has migrated offsite. The VSI will generally be limited to collecting visual evidence of potential releases (i.e., photographic documentation), although it may be appropriate in some cases to conduct air monitoring for safety purposes in the VSI.

C. Product

Visual evidence gathered during the VSI will support the initial information gathered during the PR on the likelihood of release at specific locations in the facility. This information should be evaluated along with the original information collected during the PR and integrated into the draft RFA report. Initial determinations on the likelihood of release at the facility should be revised accordingly. Typical VSIs will result in substantial documentation of facility characteristics, which should be integrated into the RFA report.

II. PLANNING THE VISUAL SITE INSPECTION

The VSI is a relatively simple procedure and should not require a great deal of time to plan and execute. In general, the site inspection activities can be completed in one day, although there may be some extremely large facilities which will require more time.

The PR provides most of the information needed to prepare for conducting the VSI. During the PR, the investigator will identify potential areas of release on a facility map, and make preliminary evaluations of the likelihood of release at each location. The investigator should rely upon this map when conducting the VSI, documenting any unusual observations on the map and in a logbook.

The VSI will usually be the investigator's first visit to the facility during the corrective action process. Therefore, the investigator should develop a site safety plan prior to conducting the VSI which outlines the need for personal safety devices (e.g., respirators, protective clothing, etc.) while conducting the field activities. The exact content of each safety plan will vary by site, depending on the complexity of the site and on the investigator's planned activities. EPA personnel should participate in an Agency-sponsored safety course prior to conducting a VSI. Safety preparation is discussed further in Chapter Four (see "Preparing for the Sampling Visit") and Appendix E.

The VSI will probably be the owner/operator's first experience with the new RCRA corrective action program as well. The investigator should contact the owner/operator to schedule a date for the VSI. At this time, he/she should also request a meeting with representatives from the facility prior to conducting the field activities. This meeting will provide the investigator with an opportunity to explain the various steps of the corrective action process to the owner/operator, and to answer any of the owner/operator's questions about the RFA or the corrective action program. During this meeting, the investigator should discuss with the owner/operator the proposed safety plan and incorporate his/her recommendations in the safety plan prior to conducting the VSI.

III. CONDUCTING FIELD ACTIVITIES DURING THE VSI

Once the investigator has made the arrangements for conducting the VSI and has completed the PR, he/she should conduct the field activities. The owner/operator will usually accompany the investigator around the facility.

During the VSI, the investigator should:

- make visual observations of SWMUs and other areas of concern at the facility;
- identify on a facility map all areas of concern;
- document all observations in a field logbook;
- take photographs of all SWMUs, potential releases, and other locations of interest; and
- monitor for vapor emissions where appropriate to protect the investigator's safety.

One of the primary purposes of the RFA will be to allow the investigator to identify potential releases of concern not identified during the PR. The VSI also provides the investigator with an opportunity to inspect the entire facility for potential releases of concern and to gain insight into facility management practices.

The investigator will focus in the VSI on identifying and characterizing SWMUs, as defined in the Introduction. The §3004(u) corrective action permitting authority requires that corrective action be addressed at all SWMUs. In some cases, however, he/she will identify spills or other releases from waste management activities which may require corrective action. These should also be inspected fully in the VSI.

Finally, there may be situations where releases of concern from manufacturing processes or product storage areas may be observed during the VSI. The investigator should document and photograph the presence of these releases. It may be necessary in some cases to use CERCLA or TSCA investigative or enforcement authorities to address these releases.

Field activities should be photographed carefuly to document all visual observations. This will be especially important at facilities where the VSI represents the last step in the RFA. For additional discussion of photographic documentation procedures, refer to Chapter 4, Section III.C.

The investigator should obtain information on each potential release based upon the five categories of information shown in the RFA Information Matrix (Exhibit 1-1): unit characteristics, waste characteristics, pollutant migration pathways, evidence of release, and exposure potential. The following sections briefly describe some of the types of information that may be found in each of these categories.

A. Obtaining Visual Evidence of Unit Characteristics

The VSI can provide useful information on unit characteristics at RCRA facilities. Observations concerning the integrity, location, and design of a unit can provide a great deal of information on the likelihood that it has released. For example, above-ground tanks can be inspected for the integrity of seams and for the presence of adequate secondary containment. The investigator may be able to screen from further investigation an above-ground tank where these factors, in conjunction with the other four categories, appear to be adequate to determine that no release of hazardous wastes or constituents has occurred or is occurring.

Surface impoundments should be inspected for the adequacy of berms, overtopping controls, and devices for the control of volatile emissions. Landfills should be inspected for the presence of runoff controls, erosion around the unit, and the potential for particulate releases posing concern. In general, it will not be possible to visually assess these units for ground-water releases during the VSI. However, the investigator should note any significant visible deterioration of containment liners.

B. Obtaining Visual Evidence of Waste Characteristics

In general, it will not be possible to obtain a great deal of information during the VSI on waste characteristics. In cases where the types of waste handled in a unit are not known, it will seldom be possible to determine their characteristics through visual observation. These will be determined primarily during the sampling visit (SV). There will be some unusual cases, however, where the investigator may find tanks or drums with labels indicating that they contain hazardous wastes or constituents. These locations should be documented carefully during the VSI.

C. Obtaining Visual Evidence of Pollutant Migration Pathways

The VSI will provide useful information on potential pollutant migration pathways at the facility. Facility characteristics that can facilitate the movement of releases from the immediate area around a unit but have not been identified previously on the facility map will often be apparent during the VSI. For example, erosion gullies at the base of landfills or surface impoundments will provide direct pathways for surface water and soil releases from these units. These pathways will be especially visible after a recent precipitation event; whenever possible, VSIs should be conducted soon after such events to help identify these runoff pathways.

The investigator should locate all potential migration pathways of concern on the facility map. These will be important areas for sampling should it be necessary to conduct a SV at these units. In addition, the investigator should correlate photographs of these pathways and their documentation on the map whenever possible.

D. Obtaining Visual Evidence of Release

The investigator should inspect the entire facility for visual evidence of release. While it will not always be possible to determine conclusively that a release has occurred based on visual evidence, such evidence can provide a strong indication that one has occurred. Visual evidence of release, coupled with information indicating that a unit contained hazardous constituents, will often be sufficient to compel further investigation in an RFI.

The investigator should look for obvious signs of release, such as: discolored soils, dead vegetation or animals, etc. The media-specific chapters describe in detail the types of visual evidence that may be apparent at various types of waste management units.

E. Obtaining Visual Evidence of Exposure Potential

The VSI will provide only limited information on exposure potential at the facility. The VSI should include an investigation of the area around the facility to determine if there are potential off-site releases and documenting evidence of such releases. In most cases, the PR will have identified whether there are nearby residences, streams, and lakes. At a minimum, the VSI should note any locations not identified in the PR where the public could be exposed to releases.

IV. DETERMINING THE NEED FOR FURTHER ACTION DURING THE RFA

The results of the VSI should be incorporated into the draft RFA report begun upon completing the PR. The results of the PR and the VSI together will provide sufficient evidence for each potential release of concern to determine either: 1) the need for a sampling visit (SV) in the RFA, 2) the need for interim measures, 3) the need for further investigation in an RFI, or 4) the need for no further action. It is crucial that the investigator document the results of the VSI in a concise and thorough manner in the RFA report. These data, together with information obtained during the PR, must be sufficient to support decisions regarding the necessity of additional action at the facility, and are likely to be closely scrutinized or possibly challenged. As stated previously, the RFA report will be the primary legal document supporting the Agency's initial corrective action activities at the facility. Incomplete, contradictory, or obscure information in the RFA report may jeopardize the Agency's position.

The following sections discuss each of the possible recommendations that can be made after completing the PR and the VSI.

A. Determining the Need for a Sampling Visit

By the end of the VSI, the investigator will have collected information on each potential release of concern and will have made a preliminary evaluation concerning the likelihood of release at each location. He/she will also have identified important data gaps that interfer with the ability to make an enforceable determination of release potential. In many cases, the investigator will recommend the collection of new environmental samples from the facility during the RFA to support his/her recommendations for further action during the RCRA corrective action process.

The need for sampling at specific units will depend upon several important factors, including: the complexity of the unit and environmental setting, the quantity and quality of information gathered during the PR and VSI, the preliminary recommendations for further action at the facility, and the cooperativeness of the owner/operator. The investigator must consider these factors and rely upon his/her professional judgment in determining when and where it will be useful to collect samples in the SV.

The preliminary recommendations for further action at a facility can play an important role in determining the need for and extent of sampling in the SV. If the investigator believes that a SWMU may have a release he/she may want to collect samples in the SV to support the decision to require further investigation. Sampling conducted during a SV can be an important supplement to information gathered during the PR and VSI, and provide the documentation necessary for developing enforceable permit conditions.

On the other hand, if the investigator believes it is unlikely that a SWMU has released or that other areas actually present problems, he/she may make a preliminary recommendation that the unit will not need investigation in an RFI. It will often be useful to support this recommendation with appropriate environmental samples at the unit which will demonstrate that there is no evidence that a release of concern is present. This will provide valuable evidence to support the investigator's recommendation should it be contested in a public hearing. It is likely to be just as important to sample at units which will not require an RFI as at those where one will be required.

There will be situations where the investigator makes a preliminary recommendation that a unit should be investigated in an RFI without actual sampling data demonstrating a release. In some cases, it may be possible to make this recommendation without taking additional samples in a SV. More typically, however, the investigator will take samples at these units in order to demonstrate that a release has occurred. More enforceable permit conditions or enforcement orders can be developed when supported by sampling evidence.

Taking environmental samples will be especially important when the investigator believes the owner/operator will be unlikely to cooperate in conducting an RFI at the facility. When the owner/operator's cooperativeness is questionable, the investigator should usually take samples to support recommendations for further steps in the corrective action process, in case these recommendations are contested in an administrative hearing. Even the most cooperative owner/operator, however, can challenge permit conditions which are not supported by strong evidence.

B. Determining the Need for Interim Measures

The investigator can recommend implementation of interim measures at any time during the RFA, although he/she may not have sufficient information prior to the VSI to make this recommendation. Interim measures should be conducted at the facility whenever there may be a significant risk of immediate exposure resulting from releases at the facility. Interim measures typically include such actions as repacking damaged drums, requiring safety precautions for workers at the facility, or fencing off areas of concern near the facility.

Details on planning and implementing interim measures can be found in the RCRA §3008(h) Corrective Action Orders Interim Measures Guidance (Draft). The investigator should consult this document when determining the need for such immediate actions at a facility. Interim measures are applicable to a facility whether it is conducting corrective action under §3008(h), §3004(u), or §3004(v).

C. Determining the Need for a Remedial Investigation

Releases and likely releases that are identified during the RFA as requiring further investigation will be fully characterized during the remedial investigation phase of the RCRA corrective action process. The RFI will be conducted by the owner/operator and may be an extremely resource intensive activity. For this reason, it will be necessary to ensure that recommendations for RFIs at facilities are supported by sufficient evidence collected during the PR, the VSI, and the SV. In most situations, the investigator will choose to collect samples at questionable units in order to support recommendations at the end of the RFA.

There will be cases, however, where the investigator will recommend an RFI for particular units without collecting additional samples in an SV. This will usually take place at facilities where it was possible to evaluate a large amount of high quality evidence of release during the PR and VSI. In these cases, the existing evidence of release must be sufficient to stand alone, without supplemental sampling, in justifying an RFI. EPA should collect additional sampling data whenever necessary, to develop strong enforceable permit conditions.

CHAPTER FOUR

CONDUCTING THE SAMPLING VISIT

I. INTRODUCTION

A. Purpose

The sampling visit (SV) is the third step of the three-step RFA process designed to identify releases at RCRA facilities. The SV focuses on collecting additional sampling information to fill data gaps that remain upon completion of the PR and VSI to enable the investigator to make release determinations in the RFA.

By the end of the SV, the investigator will have completed the first phase of the RCRA corrective action process, and should have identified all releases or potential releases requiring further investigation at a facility.

B. Scope

The scope of the SV is limited. It is EPA's objective to focus the collection and analysis of new sampling data in making preliminary release determinations, and rely upon existing information sources identified in the PR and technical judgments as much as possible. By identifying specific areas where new information is needed during the PR and VSI, it should be possible to conduct focused, limited SVs that will enable the investigator to identify releases. EPA will defer major new data gathering efforts to the RCRA Facility Investigation (RFI) phase of the corrective action process.

As discussed previously, the RFA should examine each SWMU or group of SWMUs at a facility. It will seldom be necessary to investigate each SWMU in a SV, as the PR and VSI will often provide sufficient information to make release determinations.

The extent of the SV at a facility will vary on a case-by-case basis, and will depend upon the amount and quality of information gathered in the PR and VSI. The investigator's professional judgment regarding the amount of information necessary to make an initial release determination will influence the extent of the SV. These determinations should consider a number of factors including the degree of owner/operator cooperation and the regulatory action planned for requiring further action. While investigators are encouraged to minimize the amount of sampling conducted during the SV, certain situations may require extensive sampling.

As discussed in Chapter One, Regions may rely under special circumstances upon facility owner/operators to develop a sampling plan and to conduct sampling and analysis activities during the SV. In these cases, the Regions should review and approve the owner/operator activities to ensure the quality of the new data. This chapter describes these oversight responsibilities.

This chapter provides guidance to the investigator on the following aspects of an SV:

(1) Developing a sampling plan;

(2) Preparing for the sampling visit;

(3) Conducting the sampling visit; and

(4) Making final RFA recommendations for further action.

C. Product

The results of the SV should be incorporated into the draft RFA report begun after the PR and VSI activities. Because the objectives of the SV are to fill data gaps identified previously and to assist the investigator in making final recommendations at the facility, it should be a straightforward matter to integrate the SV findings into the RFA report.

II. DEVELOPING A SAMPLING PLAN

One of the major purposes of the PR and VSI is to make a preliminary assessment of the need for further investigation at locations of concern throughout the facility and to focus the SV. This section describes the major factors in developing a sampling plan:

(1) How to determine the need for collecting sampling information during an SV; and

(2) How to develop a sampling plan for the facility where appropriate.

A. Determining the Need for Sampling at Facilities

The need for additional sampling of potential releases of concern will vary on a case-by-case basis, and the investigator should rely upon best professional judgment in determining when it will be appropriate. The investigator may choose to sample in these situations:

- to collect additional information to suppport a determination that a unit or facility does not need an RFI;

- to collect additional information when the investigator is unsure whether a release has occurred; and

- to collect additional information to confirm a determination of release and to compel an owner/operator to begin an RFI (or some other further action).

In some cases, the information gathered in the PR and VSI may provide sufficient evidence to indicate the need for an RFI at a facility, or conversely, that no further action is necessary at a facility. For example, if previous ground-water monitoring results clearly indicate that an old, closed landfill has released hazardous constituents to a surficial aquifer, the investigator will have sufficient evidence to compel the owner/operator to conduct an RFI at the unit, and it will not be necessary to conduct additional sampling. Facility records reviewed during the PR may indicate that an old, closed surface impoundment never contained hazardous constituents, and ground-water monitoring data indicate that the SWMU has not released. In this case, also, it would not be necessary to take samples to support a determination that no further action is necessary at this time.

In many cases, the information gathered in the PR and VSI will not be sufficient to enable the investigator to determine conclusively that a SWMU has or has not released. For example, a facility may have clean closed a surface impoundment several years ago that once contained sludges analyzed to be marginally EP toxic for a heavy metal. It may not be clear whether or not the impoundment released constituents to the ground water in the past, or whether any contaminated soil remains which could leach contaminants to the ground water. It may be necessary to sample the soils around the closed unit or to sample the ground water (from existing wells) downgradient from the unit in order to identify a release.

Sampling may also be necessary at SWMUs where records do not indicate what wastes were disposed in them. Old landfills and surface impoundments without information on prior wastes may require sampling; however, due to the danger involved when coring or drilling into old waste, this is best left for an RFI.

In cases such as the previous one, the investigator may determine, based upon best professional judgment, that a release is likely to have occurred at a unit. At facilities with cooperative owner/operators, it may be possible to move directly to an RFI without collecting new sampling information, even though the evidence does not conclusively indicate that a release has occurred. However, at some facilities, it may be necessary to conduct sampling in the SV in order to confirm or deny the presence of a release before moving further in the corrective action process.

B. Developing a Sampling Plan

The sampling plan will be the primary document directing the collection of additional information in the SV. When the investigator determines that sampling is necessary at a facility, it will be important to clearly specify the data that are required and the reasons for obtaining it. Investigators should remain focused on the objectives of collecting additional information at each unit, because the choice and extent of sampling locations, methods, and parameters will be critical to their ability to make meaningful release determinations.

The sampling plan should be developed to collect evidence the investigator needs to make a release determination at a SWMU, group of SWMUs, or other locations of concern. This may involve collecting direct evidence (e.g., air samples from above or around a surface impoundment) or indirect evidence (e,g, groundwater sampling at a well downgradient from the SWMU) of a release. In most cases, the investigator will collect samples from the waste source and/or from an environmental medium, and based upon knowledge of the pollutant migration pathway, deduce the likelihood that the constituent originated in the SWMU.

The sampling plan may be developed by EPA, a contractor, the owner/operator, or a combination of these, depending upon the situation. In all cases, EPA should review and approve the sampling plan carefully before initiating sampling activities. Even in cases where EPA develops the sampling plan, it is important to review the plan in order to ensure that it meets its intended objectives. Due to the cost and time involved in an SV, it may be necessary to revise sampling plans several times through an iterative process before finally beginning work.

The remainder of this section describes how to:

(1) determine the extent and locations of sampling at the facility;

(2) determine sampling methods and parameters;

(3) format the sampling plan; and

(4) review sampling plans.

1. Determining the Extent and Locations of Sampling at the Facility

Once the investigator has determined the need to collect additional information at various SWMUs or other areas of concern, he/she will need to determine how much sampling will be necessary. As stated previously, Headquarters encourages the Regions and States to limit the amount of sampling information collected during the SV to that necessary to support a release determination.

Because of the time and personnel required to conduct sampling, the information collected should be as concise and focused as possible.

The extent of sampling required in the SV will vary on a case-by-case basis, and will depend upon the investigator's best professional judgment concerning the need for new information. Several factors will play a role in determining the extent of sampling at the facility:

- The extent of information gathered during the PR and VSI;
- The cooperativeness of the owner/operator; and
- The complexity of the unit and the potential environmental media of concern.

The following guideline should be followed when determining how much sampling is required: The stronger the case that needs to be made to compel an owner/operator to conduct an RFI, or to convince the public that a SWMU does not pose a threat, the more information that should be collected in the SV.

In general, the investigator should seek evidence that a constituent identified in a SWMU has migrated to one of the environmental media. In such cases, one positive sample confirming the presence of the constituent of concern in a well-defined migration pathway may be sufficient to compel the owner/operator to conduct an RFI. However, it may be necessary to take samples at several different points around a unit to ensure that all of the potential migration pathways have been sampled.

Detailed information on pollutant migration pathways in each of the environmental media is presented in Chapters Five through Nine. The investigator should identify the potential migration pathways of concern for each SWMU during the PR and VSI. The location and number of samples necessary to identify a release will vary by unit type and by the migration pathway being investigated. For example, one groundwater monitoring well may be insufficient to identify a release from a closed landfill due to the complexities of the ground-water pathway. However, it may only be necessary to take one hNU reading from above or around a wastewater treatment unit in order to identify an air release. Each of the media-specific chapters contains specific details on determining the extent and location of sampling.

When the investigator has reason to believe that an owner/operator is likely to contest EPA's determination that a SWMU should be investigated in an RFI, the investigator should be sure to gather sufficient sampling information to support his/her judgment on the likelihood of release. Should it be necessary to compel the owner/operator to conduct an RFI through an enforcement order and administrative hearing, the outcome will depend greatly on the quality and conclusiveness of the data. Similarly the

Agency will require strong data when defending its actions in a public hearing.

2. Choosing Sampling Methods and Parameters

The investigator should choose appropriate sampling methods and parameters during the SV in order to obtain meaningful sampling results. The sampling plan should specify what methods and parameters will be used at each sampling location at the facility. It should also specify the number of samples to be taken at each sampling point (sampling SOPs and QA/QC guidelines are discussed later in this chapter). The media-specific chapters describe many of the sampling methods which will be most valuable during the SV and the criteria for choosing them.

In general, it will be possible to choose sampling techniques and parameters which provide information on the unit ranging from general indications of a release to precise, quantitative evidence of a release. In some cases, it may be appropriate to take screening level measurements (e.g., a VOC measurement with an hNU photoionizer), while in other cases it may be necessary to sample for specific organic or inorganic compounds. As stated previously, sampling for specific compounds will generally provide the most useful results during the SV. This will aid in developing a more defensible Remedial Investigation Plan.

Sampling for indicator parameters such as total organic halogens (TOX), conductivity, or pH may be useful when the investigator has little or no idea what wastes may have been released to a medium. However, these parameters can give only limited information and will not provide sufficient evidence of release in most cases. Whenever possible, it will be advantageous to identify the constituents of concern at each SMWU and sample for those specific parameters.

The investigator should choose those sampling methods that will provide the most usable results. In some cases, there may only be one method appropriate for sampling a specific medium (e.g., the presence of methane is normally monitored with a combustible gas meter). However, there will be cases where several methods may provide evidence of release.

For example, when investigating ground-water releases from old landfills where existing monitoring wells are present, the investigator should sample the ground water in order to identify releases. However, existing monitoring wells may not always be located sufficiently close to SWMUs to provide meaningful data on releases. In these cases, it may be necessary to take a number of soil samples around the unit and/or in the unsaturated zone beneath the landfill in order to identify evidence of releases. Alternatively, there may be instances where electromagnetic conductivity (EM) testing or soil gas testing will provide useful screening level information on prior releases at such units. Finally, there may be unusual situations where the investigator will need to drill new ground-water monitoring wells in order to obtain information on ground-water contamination. The investigator should be familiar with each of the potentially appropriate sampling techniques and choose the best ones for each situation. The media-specific chapters provide details on how to choose appropriate sampling techniques.

3. Format for Sampling Plan

The sampling plan should be clear and understandable and present logical actions for meeting the sampling objectives at each SWMU, group of SWMUs, or other locations of concern. The investigator should organize the sampling plan to identify the actions to be taken at the facility. Depending upon the facility characteristics, it may be appropriate to organize it by location or by sampling technique. For example, there could be sections for each SWMU that describe all of the sampling activities associated with it; alternatively, there would be a section on soil sampling that identifies all of the locations and methodologies for sampling the soil throughout the facility.

The sampling plan should include information on each of the following factors:

- Field operation

  The sampling plan should discuss the sequence for conducting the field activities.

- Sampling locations/rationale

  As precisely as possible, the sampling plan should identify the location of each sample. A site map should be prepared to guide the investigator to the appropriate locations. Specific sampling methods, the number of samples, the parameters being sampled, and a description of the objectives for each sampling activity should be included in the sampling plan.

- Analytical requirements

  The sampling plan should discuss the technique and level of detection that will be used to analyze each sample.

- Sample handling

  Sample preservation and other handling practices should be described.

- Quality assurance/quality control

  The plan should identify the number and type of quality assurance samples, specifically the number of blanks, duplicates, or spikes that will be taken. The specific QA/QC guidelines to be followed in this program are to be stipulated by each Region.

- Equipment decontamination

  The sampling plan should identify the reagents and any special procedures associated with equipment decontamination.

- Chain of custody

  All samples collected (including blanks and spikes) must be maintained under chain-of-custody procedures. Chain-of-custody minimizes the potential for damaging or losing samples before they are analyzed. Chain-of-custody tracks the possession of a sample from the time of collection, through all transfers of custody, to when it is received in the laboratory, where internal laboratory chain-of-custody procedures take over. Investigators should generally follow regional protocols for chain-of-custody procedures.

4. Reviewing a Sampling Plan

The investigator should review the sampling plan carefully to ensure that it meets EPA's objectives at each unit being sampled. The investigator should be sure that appropriate sampling methods and locations are selected, and that the extent of sampling is appropriate for the determinations that are made at each sampling location. This will be especially important when the owner/operator or an EPA contractor develops the sampling plan; however, even when the EPA investigator develops the sampling plan, it will be useful to review the plan in order to ensure its completeness.

The sampling plan also describes the level of effort required to conduct the proposed sampling strategy. This information is usually presented in terms of person/hours for each sampling technique or SWMU investigated, and may also include an estimate of the elapsed time and the total costs.

III. PREPARING FOR THE SAMPLING VISIT

The investigator should plan a number of activities prior to initiating the SV activities at a site. Once the sampling plan has been completed, reviewed, and finalized, the investigator can make plans to begin the on-site activities. These plans will include:

(1) Gaining facility access;

(2) Handling community relations (if appropriate);

(3) Preparing a safety plan; and

(4) Specifying EPA oversight of owner/operator sampling activities.

A. Gaining Facility Access

Prior to conducting the field work, the investigator should contact the owner/operator to schedule a time for the SV team to enter the site and perform the necessary field activities. Although EPA staff may already be coordinating activities for the RFA with the owner/operator, the appropriate regional person should contact the owner/operator to verify dates and describe the nature of the field activities--sample collection, photographic documentation, facility inspection, and/or instrument monitoring.

If the owner/operator is responsible for collecting and analyzing the samples, then the EPA official should contact the owner/operator to schedule a date to oversee the field activities. The agency should send the sampling plan and procedures for performing the sample collection to the owner/operator sufficiently ahead of time for him to obtain the appropriate support. If EPA is collecting and analyzing the samples, EPA should offer the owner/operator a split of all samples collected. If the owner/operator wishes to have splits, EPA should instruct him to provide analytical sample bottles for the splits.

After completing these arrangements, EPA should send a letter to the owner/operator confirming the dates and field activities. If access is denied, Appendix D provides guidance on how to obtain access to a facility.

In some cases it may be necessary to access adjacent or nearby properties in order to conduct a visual inspection or collect samples. EPA should provide verbal as well as written notification of the dates and nature of the work to owners of these properties.

Although the RCRA investigator is authorized to inspect a facility and collect samples and photographs, the owner/operator can require the investigator to conduct the inspection and sample collection activities to protect his legitimate rights. The admissibility of data in court may later be challenged if data are collected in violation of the owner/operator's constitutional rights. The owner/operator can observe inspection activities, unless he interferes with the safe, or technically sound, conduct at the sampling visit.

The owner/operator has the right to request confidential treatment of Confidential Business Information (CBI). Ordinarily, environmental monitoring data are not confidential. If data deemed confidential by the owner/operator are needed to properly evaluate the facility, then the investigator should include a precise description of the confidential data in the field log book. The investigator should instruct the owner/operator to follow up with a letter identifying the confidential data and explaining the reason why the data are business confidential. EPA regulations governing treatment and handling of confidential data are delineated in 40 CFR Part 2, Subpart B, Sections 2.201 through 2.309.

B. Community Relations

If it is necessary to conduct field activities in or near residential or non-industrial business areas, then the agency should contact the appropriate local officials ahead of time. It is difficult to remain unobtrusive while conducting site inspections, particularly if field workers are wearing protective clothing. Moreover, the presence of "official" people collecting samples can cause alarm. In some cases, it will be difficult to prevent this but prior, well-handled community contact can minimize the alarm.

The Office of Solid Waste is preparing guidance on community relations that will be available later this year. This document will provide specific guidance on when and how to implement a community relations program at RCRA facilities.

C. Preparing a Safety Plan

Agency personnel should prepare a safety plan for each sampling visit in accordance with appropriate EPA guidance. The safety plan is usually prepared last and is tailored to the specific SV activities. For some SVs, the safety plan will be very simple and require few protective measures. Other, more problematic sites, may require use of higher levels of protection. For example, if the SV involves sampling lagoons, then the safety requirements will be more involved than for one involving simple visual reconnaissance. In developing the safety plan, the owner/operator should be asked about potential hazards in advance of field work, and should consult the Facility Contingency Plan.

Appendix E contains Chapter 9 from EPA's Standard Operating Safety Guides, 1982 (SOSG) that explains how to develop a proper site safety plan. The SOSGs were prepared in accordance with EPA and other Federal health and safety guidelines, regulations and orders. This appendix discusses the steps involved in developing a safety plan and elaborates on the contents of each section of the plan.

A brief outline of the contents of the safety plan is provided below.

- Describe Known Hazards and Risks
- List Key Personnel and Alternates
- Identify Levels of Protection to be Worn
- Identify Work Areas
- Identify Access Control Procedures
- Describe Decontamination Procedures
- Describe Site Monitoring Program
- Identify Special Training Required
- Describe Weather-Related Precautions

EPA personnel should participate in an Agency-sponsored safety course before visiting a site.

D. EPA Oversight of Owner/Operator Sampling Activities

The sampling visit plan should include provisions for EPA oversight when the owner/operator conducts the sampling activities. The level of EPA involvement will depend upon the extent of sampling, the complexity of the site, and the cooperativeness of the owner/operator. In some cases, EPA may believe that the owner/operator can be counted on to provide reliable results. In such situations, EPA oversight of the sampling activities may be limited to presence at the facility during one day of the sampling only. In other cases, it may be necessary to provide EPA presence at the facility at all times during the sampling activities. The investigator should take splits of all samples collected by the owner/operator.

IV. CONDUCTING THE SAMPLING VISIT

The investigator may begin the site activities once he/she has completed all of the preliminary activities. The sampling visit involves gaining access to the site, performing the sampling activities, taking photographs of all activities, keeping the SV portion of the logbook, preparing samples for shipment and analysis, and, finally, decontamination/demobilization.

A. Preliminary Site Activities

The investigator should meet with the owner/operator prior to entering the facility to conduct sampling. The investigator will already have conducted a VSI; therefore, the owner/operator should have some understanding of the corrective action process from the initial meeting with the investigator(s). However, the investigator should be prepared to answer questions concerning his/her plans for sampling. In cases where the owner/operator will conduct the sampling, the investigator can make the arrangements to accompany him/her at this time. In addition, the investigator should offer to provide the owner/operator with duplicate samples.

B. Sampling Procedures

The investigator should follow the sampling plan once he/she has gained access to the facility. The sampling plan should describe all of the sampling locations, methods, and procedures to be followed. If, for any reason, it is necessary to diverge from the sampling plan, changes should be documented carefully.

Regardless of who performs the sample collection, continuous monitoring for vapor emissions is needed to detect air releases from sampling activities. If the owner/operator is collecting the samples, EPA/State investigators should document precisely the sequence of sampling activities, the procedures and instruments used, and describe the samples (including location, depth, appearance, etc.).

The EPA Regional offices have developed SOPs for most SV sampling tasks under the CERCLA PA/SI program. In addition, EPA's Office of Waste Programs Envorcement (OWPE) has developed the RCRA Ground Water Monitoring Technical Enforcement Guidance Document (TEGD) to provide guidance on well installation and sampling procedures; EPA/SW-846 also provides sampling and analysis procedures for media relevant to the SV. For the most part, these SOPs are applicable to RCRA field activities. If the SOPs are not applicable or appropriate for the particular field activity, then a new SOP should be developed. Where modifications to existing SOPs are made, they should be noted in the field logbook.

C. Photography

Investigators should use regular 35mm cameras for taking photographs. They should not use filters, as they tend to discolor the picture and may unfairly bias the result by making leachate seeps or lagoons look different from real life. The investigator should identify and record in the fieldbook the exact type of camera (including i.d. number), film (i.e., Fuji, ASA 200), and the lens used. Photographs taken with unusual lenses (e.g., wide-angle) are not admissible in court.

Photographs should be taken to document the conditions of the facility and procedures used in inspection activities. Particular emphasis should be placed on matters identified in the work plan. Types of pictures that should be taken include:

- o Representative overall picture(s) of facility;
- o Posted signs identifying ownership of facility;
- o Evidence of releases--leachate seeps, pools, discolored water, or strained soils;
- o Individual units--lagoons, drums, landfills, etc.;
- o Visual evidence of poor facility maintenance;
- o Adjacent land use; and
- o Area that unauthorized persons can easily access.

D. Logbook

The logbook is perhaps the most important document produced during the SV. It serves as a basis for integrating the SV results into the RFA report, most importantly, supporting the work done and results obtained in any future legal proceedings under RCRA or CERCLA.

A unique logbook should be developed for each site and each visit to the site. Logbooks should be bound and each page sequentially numbered. Entries into the logbook should be chronological -- a time notation should introduce each entry. The logbooks should be maintained with indelible ink.

The following types of entries should be made in the logbook:

- All personnel on site during each phase of the on site work;
- All instruments used during the field work with unique identification numbers;
- Description of film used;
- Description of the weather and changes in the weather;
- Material observations related to items identified in the work plan;
- Results of field measurements--distances, instrument readings, well measurements, locations;
- Factual descriptions of structures and features--wells and well construction, units, containment structures, buildings, roads, topographic and geomorphic features, locations;
- Signs of contamination--oily discharges, discolored surfaces, dead or stressed vegetation;
- Sketches of facility layout, structured features and points of contamination;
- Map of facility showing point and direction of photographs;
- Location and time of each sample; and
- Any other relevant items.

E. Sample Shipment/Sample Analysis

Upon completion of the onsite work EPA or the owner/operator should deliver all samples to the laboratory for analysis. SOPs covering sample shipping are available in each of the regional offices or in EPA safety training manuals. The time involved in analyzing samples can vary from 40 days to three to four months.

F. Decontamination/Demobilization

Decontamination of persons and equipment occurs not only at the completion of all field work but each time persons exit the site, including rest breaks.

In many cases, decontamination may be very simple, e.g., removing disposable coveralls and washing field boots. Decontamination after sampling activities will usually include decontamination of field persons, and sampling and field equipment.

All clothing and support materials that will not be reused should be containerized either for transport and eventual off-site disposal or for on-site disposal.

V. FINAL RFA RECOMMENDATIONS FOR FURTHER ACTION

The final task in the RFA process is to make recommendations concerning the need for further actions at the facility. These recommendations include: (1) taking no further action; (2) conducting an RFI to identify the rate and extent of releases from SWMUs, groups of SWMUs, or other releases of concern; (3) planning and implementing interim measures at the facility; or (4) referring the further investigation and control of permitted SWMU releases or other unusual releases to other environmental program offices. The investigator will have completed the RFA only after recommendations have been made which cover all potential releases of concern investigated in the RFA.

In order to make these recommendations, the investigator may make determinations concerning the likelihood of release for some SWMUs after completing the PR and VSI. In other cases, it will not be possible to make determinations until sampling results from the SV have been evaluated. We discuss below how to make final release determinations at the end of the RFA and how to make recommendations for further action.

A. Making RFA Release Determinations

1. Evaluating Sampling Results from SV Activities

The first step in making an RFA release determination will require the investigator to use best professional judgment in evaluating the sampling results from the SV. This evaluation should be straightforward as long as the sampling plan was developed correctly, e.g., sampling points were selected to provide enough additional evidence to support this determination.

After the laboratory completes its analysis, the investigator can evaluate the validity of the analytical results from the sampling activities. When EPA conducts the sampling, preliminary review of analytical data involves ensuring that all deliverables required by the CLP are included in the data package, checking that all forms are completed within the requirements of the contract, and identifying the key quality assurance items in the data package. The EPA Regional Environmental Services Divisions (ESDs) will perform a qualitative analysis of the data after this preliminary data review, and determine if the data results are valid. When the sampling is conducted by the owner/operator, the investigator should rely upon best professional judgment in evaluating the validity of the lab results.

2. Integrating Data Collected During the PR, VSI, and SV

Once the investigator has evaluated the validity of the sampling results, he/she should incorporate this additional data with the information collected previously on each release location. By this point in the process, the investigator should have all additional information that was requested of the owner/operator to facilitate determining the likelihood of a release.

3. Determining the Likelihood of Release

The investigator should rely upon his/her best professional judgment at the end of the RFA process to determine the likelihood of release to all environmental media for all SWMUs and other areas of concern. The VSI chapter described how the investigator should make initial determinations of release at each SWMU, group of SWMUs, or other potential areas of concern. The investigator will use the same basic judgment at the end of the SV; the primary difference will be that there should be additional information to support a determination after conducting the SV.

The investigator should determine the likelihood that a SWMU has released by evaluating evidence collected in the RFA. In some cases, the investigator will have direct evidence of a release, which will provide the strongest support for a determination. In most cases, the investigator will be required to make deductions from indirect evidence about the likelihood of release. As stated previously, the strength of these deductions will depend upon the quality of the waste information, the extent to which the pollutant migration pathways have been characterized, and the quality of the environmental sampling results and visual observations.

The level of evidence needed to support a determination will vary on a case-by-case basis, depending upon the cooperativeness of the owner/operator, the EPA objectives at the facility, and the complexity of the facility. In general, it will be sufficient to identify one constituent that is present in both a SMWU and in the migration pathway to support a release determination. The investigator does not need to demonstrate with statistical confidence that the SWMU has released during the RFA.

B. Making Recommendations for Each SWMU or Group of SWMUs

The final step in the RFA will entail making recommendations concerning the need for further investigations under the corrective action authority, based upon the release determinations described above. This section describes each of the four possible recommendations below: no further investigation, investigate further in an RFI, plan and implement interim corrective measures, and refer the control of a permitted release to another environmental program office.

1. No Further Investigation

Investigators may conclude that a SWMU, a grouping of SWMUs, or an entire facility does not require further investigation based on the information available from the PR and a visual inspection. In some cases it will be advisable to collect some sampling and analytical data to confirm that a unit or area has not created a release that poses a threat to human health and the environment. For many SWMUs, the determination that no further investigation is necessary will be relatively simple and straightforward.

Some units will have design and operating characteristics which will effectively prevent releases to the environment. For example, a wastewater treatment unit may have a cover to prevent the release of VOCs to the air; such a unit would not require further investigation for air releases.

SWMUs which never contained constituents of concern will not require further investigation.

It is also appropriate to eliminate certain units from further study on the basis that they clearly have not released hazardous wastes or constituents into the environment. Examples of such units include elevated tanks and, in some cases, surface level storage tanks. In the case of aboveground tanks, unit design and operation, plus the inspector's direct knowledge of the facility, can provide sound evidence that the unit has not caused a significant release. It will rarely be possible to make such determinations for landfills and surface impoundments. More explicit information as to making a "no further action" determination is presented in the media-specific chapters.

2. Investigate Releases Further in a RCRA Remedial Investigation

The investigator should recommend that a SWMU or other release be investigated further in an RFI when he/she identifies a SWMU with a likelihood (or documented evidence) of a release which may pose a potential threat to human health and the environment. He/she should describe each SMWU and the relevant environmental media which should be investigated in the RFI. It will be important in focusing the RFI to determine which media are of concern for each SWMU or potential release.

There are situations where the facility as a whole poses a problem and where it is difficult to distinguish between individual SWMUs as sources of contamination. In these cases, it may be more efficient to refer the entire facility to the RFI and require the owner/operator to investigate the facility as a whole.

3. Adopt Interim Measures

The RFA should result in a recommendation to adopt interim measures at the facility when the investigator believes immediate action should be taken to protect human health or the environment from releases. The investigator should evaluate the severity of the release and the proximity of potential receptors when assessing the need for interim corrective measures.

Temporary corrective measures may be appropriate in situations where there is a release of hazardous wastes or constituents into the environment that is currently affecting or will affect target populations or sensitive environments and the release may be temporarily or permanently arrested by some type of interim solution.

The RCRA §3008(h) Corrective Action Orders Interim Measures Guidance (draft) provides details on appropriate actions to take in situations where immediate action is needed. Examples of interim measures include: fencing a facility in order to prevent direct contact with wastes; or stabilizing weak dikes to prevent further surface water releases from impoundments. It is important that these units should be investigated further in an RFI in order to determine the adequacy of the interim measure and/or to design a permanent solution.

4. Refer Permitted Release to Other Program Offices

Permitted releases which may either directly or indirectly be posing a threat to human health or the environment should be referred to the State or Federal program office that issued the permit. EPA has not developed guidelines on such referrals, thus they should be conducted as necessary on a case-by-case basis. When the other program office cannot or will not investigate or control the release, the investigator may recommend that the units be investigated in an RFI and/or that interim measures be initiated.

When the RFA identifies contamination resulting from permitted discharges or discharges requiring permits that require further investigation in an RFI, EPA will work on a case-by-case basis with the Regions and other EPA permit programs to develop a solution to the contamination resulting from the discharges. For example, when frequent violations of NPDES permits in the past have resulted in an accumulation of hazardous materials in stream sediments, the RCRA investigator should work with the NPDES authority to develop a solution to the contamination.

VI. FINAL RFA PRODUCT

The final RFA report will document the activities undertaken in the PR, VSI, and SV. Many documents will be generated during the SV, including a sampling plan, safety plan, sampling results, an evaluation of the sampling results, and release determinations and recommendations for each unit. All of this information should be compiled into the RFA report for future reference during further phases of the corrective action program. Appendix A provides a sample outline for the RFA report.

CHAPTER FIVE

GROUND WATER

I. INTRODUCTION

A. Purpose

This chapter provides technical information to support the investigation of releases to ground water, with the exception of releases from regulated units, during the RFA. While Chapters Two through Four provide general guidance on conducting an RFA, this chapter focuses on specific factors unique to the ground-water medium that should be considered by the investigator.

B. Scope

The scope of the RFA, discussed in Chapter One, extends to all operating, closed, or closing RCRA facilities. The investigator should evaluate the likelihood that a facility may have releases to the ground water, with the exception of "regulated units" (land disposal units that received wastes after July 26, 1982). Releases to ground water from regulated units should be addressed in permits according to the requirements of Subpart F of Part 264 (or corresponding State regulations), rather than through §3004(u). The investigation of ground-water contamination from regulated units will not be part of the RFA.

It is not the purpose of the RFA to install Subpart F montoring wells in order to detect conclusively the presence of a release. It will usually be sufficient to demonstrate that there is a likelihood of release from a specific unit to the ground water in order to require further investigations. The investigator should rely upon best professional judgment when establishing evidence of release to ground water.

This chapter is organized to reflect the separate phases of the RFA process. The first section describes the technical factors that should be considered during the PR and VSI. The second section describes the technical approach to obtaining additional sampling information in the SV for ground water, and should be consulted along with Chapter Three on conducting a sampling visit. The final section discusses factors to consider when making release determinations for ground water at the end of the RFA. This section also presents options for further investigation of ground-water releases to be evaluated at the end of the RFA.

II. CONDUCTING A PRELIMINARY REVIEW AND VISUAL SITE INSPECTION OF GROUND-WATER RELEASE POTENTIAL

This section presents technical information related specifically to the ground-water pathway to be considered when conducting the preliminary review and visual site inspection. Accordingly, this section is organized to reflect the primary goals of the PR and VSI described in Chapters Two and Three:

- Identifying and describing potential threats to ground water at RCRA facilities; and
- Making a preliminary assessment of the need for further investigations at these facilities.

This section reflects the importance of the five categories of information to consider in conducting RFAs presented in Exhibit 1-1. It presents technical information specific to the ground-water pathway covering the five areas and technical information to help the investigator determine when additional sampling will be necessary in an SV to identify ground-water releases. The section discusses each area separately:

(1) Unit characteristics;

(2) Waste characteristics;

(3) Pollutant migration pathways;

(4) Evidence of release;

(5) Exposure potential; and

(6) Determining the need for additional sampling information.

This information will be relevant to the evaluation of written documents in the PR and information gathered in a VSI. Consult Chapters Two and Three for general guidance on how to conduct PRs and VSIs.

A. Unit Characteristics

The design and operating characteristics of a unit will determine to a great extent its potential for releasing hazardous constituents to ground water. Many treatment, storage, and disposal units are designed to prevent releases to the environment. The investigator should evaluate the unit characteristics of each SMWU or group of SWMUs at a facility to determine its potential for releasing hazardous constituents to ground water.

The general potential for ground water contamination from any unit depends, to a great extent, upon its nature and function. This concept is reflected in RCRA hazardous waste regulations. For example, ground water monitoring is not a requirement for container storage units, while monitoring is required for land-based units. Therefore, in evaluating the likelihood of ground-water releases from a unit, the investigator should assess each unit based upon:

- An understanding of the overall potential of the unit to cause ground water releases;
- An understanding of the primary mechanisms by which releases may occur from the unit; and
- An assessment of unit-specific factors which, singularly or in combination, indicate the relative likelihood of ground water releases from the unit.

The investigator should first consider the relative potential of the unit to release. Exhibit 5-1 presents a generalized ranking, in rough descending order, of different types of units and their overall potential for causing ground-water contamination. It lists the most common mechanisms by which ground-water releases can occur from each unit type.

Exhibit 5-1 provides only a very theoretical sense of the relative potential for units to cause ground water releases. Unit-specific factors should be evaluated in determining whether further ground water investigations are needed for a particular unit.

The following unit-specific factors should be evaluated in assessing a SWMU for ground water releases:

(1) Unit design;
(2) Operational history; and
(3) Physical integrity of the unit.

In making a unit assessment, the investigator should consider ways in which the above factors may combine to suggest whether or not releases have occurred. For example, examination of an above-ground tank may reveal evidence of soil contamination adjacent to the unit. However, the operational history of the unit reveals that the tank has been in operation for only six months, the tank is in good condition, and records indicate that the contamination occurred as a single, relatively small overflow event. Consideration of all of these factors indicates that, despite the evidence of soil contamination, likelihood of a release to ground water is very remote, and further remedial investigations for ground water may not be necessary. The factors listed above are discussed in more detail below.

EXHIBIT 5-1

RANKING OF UNIT POTENTIAL FOR GROUND WATER RELEASES AND MECHANISMS OF RELEASE

Unit Type	Release Mechanism
Class IV Injection Well	o Spillage or other releases from waste handling operations at the well head o Escape of wastes from well casing o Wastes are injected directly into the subsurface
Surface Impoundment	o Migration of wastes/constituents through liners (if present) and soils o Damage to liners o Overflow events and other spillage outside the impoundment o Seepage through dikes to surface and/or subsurface
Landfill	o Migration of leachate through liners (if present) and soils o Precipitation runoff to surrounding surface and subsurface o Spills and other releases outside the containment area from loading/unloading operations
Land Treatment Unit	o Migration of constituents through the unsaturated zone o Precipitation runoff to surrounding surface and subsurface
Underground Tank	o Tank shell failure o Leaks from piping and ancillary equipment o Spillage from coupling/uncoupling operations o Overflow
Waste Pile	o Leachate migration through liner (if present) and soils o Precipitation runoff to surface/subsurface
Class I Injection Well	o Spillage or other releases from waste handling operations at the well head o Escape of wastes from well casings o Migration of wastes from the injection zone through confining geologic strata to upper aquifers

EXHIBIT 5-1 (Continued)

RANKING OF UNIT POTENTIAL FOR GROUND WATER RELEASES AND MECHANISMS OF RELEASE

Unit Type	Release Mechanism
In-ground Tanks	o Overflow o Tank wall failure o Leaks from ancillary equipment o Spillage from coupling/uncoupling operations
Container Storage Unit	o Spills from containers/container failure subsequent migration through liner or base (if any) and soils o Precipitation runoff from storage areas
Above Ground Tank	o Overflow o Shell failure/corrosion o Leaks from ancillary equipment o Coupling/uncoupling operations
Incinerator	o Spillage or other releases from waste handling or preparation activities o Spills due to mechanical failure

1. Unit Design

Evaluation of the unit's design should focus on the following areas:

- The unit's capacity and dimensions;
- Materials, design, and construction of a unit;
- Any engineered features designed to prevent releases to ground water; and
- The adequacy of such features.

The capacity and dimensions of a unit affect the potential for a release in several ways depending upon the unit type. A large volume, shallow surface impoundment is more likely to have a release than a smaller capacity unit. The shallow depth with the large volume indicates that there is a large surface area on the bottom of the impoundment. Most releases occur through the bottom by exfiltration through a clay liner or through leaks in a synthetic liner. The larger the bottom surface, the greater the likelihood that bottom leaks or exfiltration will occur.

Some units have engineered features that will reduce the potential for a release to ground water. Landfills with double liners and a leachate collection system will be much less likely to have a release to ground water than do either land-based units without liners or with single clay liners. Some features installed to prevent ground water releases have different abilities to do so effectively. For example, single clay liners do not prevent releases, but they delay the movement of leachate through the less permeable clay layers.

2. Operational History

During the PR, the investigator should evaluate the unit's operational history for information that indicates a release to ground water may have occurred. Operational factors that may influence the likelihood of ground water releases include:

- Service life of the unit. Units that have been managing wastes for long periods of time usually have a greater likelihood of releases than units that have been operating for short periods of time. For example, an underground tank that has been in service for six months will have a much smaller likelihood of leakage due to corrosion than will a twenty-year old underground tank.
- Operational status. In some cases, the operational status of a storage unit (e.g. closed, inactive, decommissioned) may have an effect on the relative likelihood of a ground water release.

- **Operating procedures.** Proper maintenance, regular inspections, and procedures for ensuring waste compatibility with the unit may indicate that a unit is unlikely to have released (this is particularly true for storage units such as tanks and container storage areas). Evidence of good operational practices may be available from owner/operator records, and/or visual observation or historical inspection reports. Conversely, poor operating practices (e.g., underground tanks that are never leak tested or inspected internally, storage of open containers of wastes) may indicate relatively greater potential for ground water releases.

3. Physical Integrity of Unit

During the VSI, the investigator should examine the physical condition of the unit for indications of releases that may contaminate ground water. Deterioration of above-ground tanks should reveal obvious signs of rust, corrosion and spills. Records of recent leak inspections may also be available for both above and below ground tanks, and these should be reviewed as part of the PR.

It is likely to be difficult to evaluate the physical integrity of many land-based units. However, dikes around surface impoundments may show signs such as crumbling, slumping, and infiltration around the toe, suggesting that the integrity of the impoundment is questionable. In general, the investigator can assume that most unlined landfills and surface impoundments have leaked to ground water.

B. Waste Characteristics

The investigator should attempt to identify the wastes handled at a facility and originally contained within a SWMU or group of SWMUs during the PR. In the PR, the investigator will try to connect information on waste types, hydrogeologic characteristics, and ground-water contamination to determine whether or not a SWMU, or group of SWMUs, or other areas of concern at RCRA facilities have released constituents to the ground water. This section describes technical factors to consider when identifying waste characteristics relevant to ground-water releases. It also discusses physical/chemical properties that will affect the release potential of wastes and their subsequent transport in ground water.

The tendency for different hazardous constituents to migrate from a given unit or area, through the unsaturated zone, and into the ground water, will depend upon: the amount of waste present, its physical state (i.e., liquid or solid), and the physical and chemical properties of the constituents and the geologic materials. Many of the constituents in Appendix VIII are essentially insoluble in water (at neutral pH) and/or bind tightly to soil particles, reducing their tendency to migrate in ground water. The investigator should consider the potential mobility of the wastes in a unit, in combination with previously described unit-specific factors, when assessing the likelihood of release.

The mobility of organic constituents can be expressed quantitatively by the sorption equilibrium coefficient (K_d). The value of K_d depends upon the organic content of the soil and the constituent-specific soil adsorption coefficient (K_{oc}). In most cases, it will be more useful to estimate the relative mobility of a constituent by considering only the inherent mobility of the constituent as expressed by K_{oc}; the investigator will seldom have access to information on the organic content of soils at a facility.

Few K_{oc} values have been estimated for specific constituents; however, the octanol-water partition coefficient, (K_{ow}), can be used as an indicator of K_{oc}. Appendix E presents K_{oc} and log (K_{ow}) values for many constituents of concern for ground-water releases. Because these are log values, chemicals with K_{ow} values of more than two can be considered relatively immobile; a value of less than one indicates that the constituent is relatively mobile.

There are several limitations on using this measure of mobility. As stated above, actual constituent mobility depends upon the organic content of the soil, which will not be known in most cases. In addition, other geologic factors (e.g., faults, fractures, solution cavities) may provide open channels for the migration of contaminants which could make the application of the concept of waste mobility inappropriate in these situations. The presence of other wastes in a unit may also substantially alter the mobility of a constituent.

Hazardous metals and inorganic compounds may also be relatively mobile in ground water (e.g., arsenic and cyanides are extemely mobile constituents). Their mobility will depend upon the pH of the wastes and the ground water, the oxidation-reduction potential of the ground water, and the ligands present for complex formation (e.g., the presence of carbonate ions in the ground water will support the formation of relatively immobile metal complexes), and the geologic factors discussed above. The geochemistry of the materials underlying the facility will affect constituent mobility by governing the presence of these ligands (e.g., carbonate ions will generally predominate in limestone aquifers).

C. Pollutant Migration Pathways

The investigator should evaluate any available information pertaining to the hydrogeologic characteristics of a facility in order to determine the pollutant migration pathways associated with ground-water releases during the PR. This information, such as the direction and magnitude of ground-water flow, soil characteristics, depth to ground water, aquifer media, and climate, may play a major role in identifying ground-water releases at a facility. The investigator should rely on best professional judgment and standard geologic and hydrogeologic principles, consulting the information sources discussed in Chapter Two on the subsurface characteristics of the site.

In cases where the investigator finds little direct evidence that a particular unit had a release to ground water (e.g., documented evidence of a substantial tank leak), he/she may have to deduce the likelihood of release from a facility by linking information on wastes, units comprising the facility characteristics of the pollutant migration pathway, and evidence of ground-water contamination located in this migration pathway. This demonstration will depend primarily upon an adequate characterization of the direction and rate of ground-water flow at the facility.

The investigator may choose to recommend more detailed or immediate investigations at the end of the RFA for facilities with particularly vulnerable ground water (e.g., shallow sand and gravel aquifers). More definitive guidance on evaluating the vulnerability of ground water is contained in the criteria for determining ground water vulnerability which OSW released in July 1986, [Interim Final, July 31, 1986 "Criteria for Identifying Areas of Vulnerable Hydrogeology."] This guidance may be helpful in situations where a more complete understanding of ground water vulnerability would assist in making the necessary determinations in the RFA for a facility.

The ground water regime of the facility should be evaluated for other potential migration paths. For example, ground water often recharges surface water bodies. Locating ground-water discharge points may be important when identifying the potential for surface water releases resulting from contaminated ground water.

Evaluation of the ground-water pollutant migration pathway may also include evaluating any existing ground-water monitoring systems at the facility which may be capable of detecting releases. If it appears that an existing monitoring system may provide information on continuing releases at the facility, it may be necessary to evaluate its technical adequacy. Procedures for examining the technical adequacy of existing monitoring wells are described in Section III of this chapter.

When the investigator determines that an existing ground-water monitoring system and the sampling and analysis program are adequate to detect releases to ground water, and analytical data (e.g., within the past year) indicate that there is no release, it may not be necessary to investigate the unit or facility further.

D. Evidence of Release

The investigator should examine any available sources of information to identify evidence that constituents have been released to the ground water at a facility. The investigator should evaluate both direct and indirect evidence of release during the PR and VSI. General considerations on how to look for evidence of release are discussed in Chapters Two and Three.

Direct evidence of release to ground water may include official reports of prior release incidents, such as a major tank car spill to the ground or documentation that a surface impoundment has released to ground water (e.g., some states used to permit releases to ground water through their NPDES permitting process).

Indirect evidence of a release from the facility or a specific unit at the facility will usually entail information on general ground-water contamination. When the investigator identifies indirect evidence of a SWMU release of this type, it may be necessary to determine which SWMUs are likely to have released the relevant constituents by evaluating the pollutant migration pathways (hydrogeologic characteristics) and the waste characteristics at the facility, as discussed previously.

VSIs may detect releases to other media, particularly soils, that may indicate a high probability that contaminants have migrated to the ground water. Evidence of soil contamination, either through visual or sampling data, can provide an indication that a release to ground water has occurred.

At some facilities, ground-water sampling data may be available from wells at the facility, off-site wells, or from a spring near the facility. Other facilities may have no ground-water monitoring information relevant to the overall facility. At these facilities, the investigator should consider available data on soil contamination or results of soil gas monitoring. Electromagnetic conductivity surveys may provide evidence of release for ionic species.

At facilities with ground-water monitoring data, these data may indicate that hazardous constituents could have migrated from the facility. However, the investigator will still need to evaluate the facility's units, waste, and migration pathway characteristics, in order to support the possibility that the constituents originated from SWMUs at the facility.

E. Exposure Potential

The investigator should evaluate available information on the location, number, and characteristics of potential receptors that could be affected by ground-water releases at the facility. These receptors include human populations, animal populations (particularly any endangered or protected species), and sensitive environments.

Exposure potential information will be used primarily in helping the investigator determine the need for interim corrective measures at the facility in order to address instances of ground-water contamination posing especially high risks of exposure. Types of exposure information of concern include:

- The proximity of the unit/facility to downgradient drinking water and irrigation wells;
- The potential for use of the aquifer as a drinking water source; and
- The potential effect of aquifer discharges to nearby surface water.

F. Determining the Need for Additional Sampling Information

The investigator may not be able to determine whether a ground-water release from a unit/facility has occurred or is likely to have occurred based upon existing data and the factors described previously. In these situations, he/she should consider whether conducting a sampling visit to obtain additional evidence and fill data gaps will be needed in making a determination. In this section, we present:

1) General information on factors to consider in determining the need for additional sampling information;
2) Factors to consider in selecting sampling parameters; and
3) An example to illustrate this discussion.

1. General Information on Determining the Need for Sampling

At some facilities existing monitoring wells may be present which could detect contamination from SWMUs at the facility. Existing analytical data from such wells may, however, be inadequate or unreliable. In such situations, new analytical data may be useful in making release determinations. The following list presents situations where additional sampling data could be helpful in determining if a release has occurred:

- Available data are outdated, generally when data are over one year old;
- The analytical methods used were inappropriate, particularly if methods with very high detection levels that may obscure significant releases were used;
- QA/QC was of unknown levels or non-existent;
- QA/QC information available (e.g. contaminated field/trip blanks) suggests that available data may be invalid;
- The parameters monitored do not correspond to the waste constituents suspected from the release, due to factors such as quantity and mobility. For example, GC/MS priority pollutant scans are available to detect a release of those chemicals, however, the waste contains metallic cyanides and there is no data on either metals or cyanide in the available sampling data;

- The available data are not of a rigorous QA/QC level or may be questioned for other reasons, and it is anticipated that the facility will challenge any permit condition or enforcement order requiring an RFI; and

- The available data are based on samples taken from wells which were not adequately oriented to detect a release from a specific unit and better wells have since been installed or located but not sampled. It is not routine to require that wells be installed during an RFA.

2. Selection of Sampling Parameters

Knowledge of the wastes that may be potentially released from a unit is the starting point when identifying sampling parameters. However, many facilities have incomplete or no data on the wastes deposited over time. When little is known of the wastes managed in the unit, gas chromotography/mass spectrometry (GC/MS) scans of various constituent groups (e.g., volatiles) are often a good starting point. Investigators should select the parameters to be analyzed for based on the facility-specific information available and on the investigator's professional judgment.

When a waste source is hazardous due to EP Toxicity, the metals of concern are: arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver.

The volatile GC/MS scan identifies chemicals that are characteristic of solvents and lighter petroleum products (e.g., gasoline). Many of these compounds are readily found in the environment from releases from various waste sources. Because they are very volatile, older wastes may no longer contain these constituents since they may have been released by evaporation into the air. The indicator parameter, TOX, identifies the presence of halogenated organics. If TOX levels have been identified, a volatile scan should be helpful in identifying the specific compound released.

Acid extractable compounds may be present in heavier petroleam feedstocks, and certain industrial processes (e.g., pentachlorophenol from wood preserving). Some compounds (e.g., phenol, pentachlorophenol, 2-chlorophenol) are commonly found from many waste sources including organic waste treatment sludges. Phenol and the mono halogenated phenols biodegrade readily in most soil and surface water environments.

Base/neutral compounds can often be found in wastes from industries such as organic chemicals, plastics, and synthetic fibers manufacturers. The pesticide scan identifies pesticides that are found specifically in pesticide wastes and products from the agrichemical industry.

3. Example

An illustration of a situation in which sampling would be called for is as follows: An unlined surface impoundment, constructed twenty years ago from naturally occurring site material, is located at a facility close to homes withdrawing water from domestic wells. The onsite soils are high in clay content, although they also contain abundant cobbles which would interfere with adequate compaction.

The investigator determines that the impoundment has not received any wastes in the last five years; however, the previously deposited waste material has never been removed. The wastes are identified as unspecified waste oils from unknown sources and wastes containing lead and cadmium. While monitoring wells have been installed, the monitoring data collected from them only measure indicator parameters (e.g., pH, conductivity, TOX and TOC). Only one parameter (TOC) showed an increase over background. In addition, State sampling data from off-site domestic wells detected significantly elevated levels of lead and copper. However, the sampling protocol collected samples directly from the resident's tap, making it possible that the contamination originated in the domestic plumbing system.

Because of the unit's design, construction method, and age, the investigator may strongly suspect that a release has occurred. While monitoring data exist, indicator parameters are not adequate to identify potential releases of heavy metals. The one elevated parameter, TOC, suggests that organics may have been released from the oily wastes. However, elevated TOC values do not conclusively indicate contamination from man-made sources, and may result from natural sources.

In this scenario, the investigator should probably call for additional ground-water sampling from existing wells to find constituent-specific evidence of release not provided by the indicator parameters. He/she would probably sample both on-site and off-site wells for lead, cadmium, acid extractables, and the base/neutral priority pollutants.

The acid extractables and base/neutral priority pollutant scans would be appropriate since they can identify many of the constituents commonly found in petroleum oil based wastes (especially since the composition of the wastes was largely unknown). While it might be possible to identify other constituents at the site (e.g., VOCs), the investigator would probably limit the sampling parameters to those most likely to be present. Because of the high cost and delay associated with analyzing sampling results, the investigator should attempt to limit the selection of sampling parameters to those most likely to result in an identification of a release from.

III. COLLECTING ADDITIONAL SAMPLING INFORMATION IN THE SV

This section presents technical information related specifically to the ground-water pathway to be considered when collecting additional sampling information in the SV. The information presented here should be used to help the investigator meet one of the primary goals of the SV:

- To collect additional sampling information to fill data gaps identified in the PR and VSI leading towards a release determination.

For each sampling method discussed, this section describes: 1) the general kinds of situations in which it will be appropriate to employ a specific technique, 2) technical information on how to conduct the sampling, and 3) specific details to be considered when evaluating the sampling results. We do not provide the actual SOPs on the sampling techniques here, although we do reference the relevant manuals.

The choice of appropriate sampling methods will have a large impact on the cost and usefulness of the SV. The investigator should be confident when developing and reviewing the sampling plan that the procedures chosen will meet the needs of the RFA, while not resulting in the collection of unnecessary data. We discuss the following five sampling methods which may be of use when investigating ground-water releases in the RFA:

(1) Sampling of existing ground-water monitoring wells;

(2) Soil sampling;

(3) Soil gas monitoring;

(4) Electromagnetic conductivity mapping;

(5) Sampling of domestic wells; and

(6) Installation and sampling of new ground-water monitoring wells.

A. Sampling of Existing Ground-Water Monitoring Wells

The investigator should sample existing ground-water monitoring wells when they may provide useful data on contamination resulting from facility-wide releases. As discussed in the previous section, the investigator may decide to sample wells when the most recent data are outdated, when the laboratory analysis procedures are unknown or questionable, or when the sampling parameters were inadequate. The investigator may also choose to sample existing wells to provide EPA with data of its own when the only available data was collected by the owner/operator.

The procedures for sampling monitoring wells have been described extensively in many available documents. The investigator should rely upon his/her best professional judgment when collecting samples at existing wells. Well configurations at SWMUs should be adequate to detect releases from these units. Before collecting additional information, the investigator should ascertain the adequacy of an existing monitoring system. He/she should evaluate the locations of wells in relation to the specific SWMUs or other areas of concern. In many cases, a facility's monitoring wells will have been installed to detect contamination resulting from regulated units, and will not pick up releases from other units or areas of concern. Exhibit 5-2 depicts three examples of monitoring well systems, one that would be adequate for detecting SWMU releases and two that would be inadequate.

After assessing the adequacy of well locations, the investigator should evaluate data on well construction and design in order to determine its adequacy. While data from properly constructed wells may be of higher quality, it will not be necessary to ensure that existing wells meet the stringent requirements discussed in the RCRA Ground-water Monitoring Enforcement Guidance: RCRA Ground-water Monitoring Technical Enforcement Guidance Document (TEGD). The investigator should use best professional judgment in evaluating sampling data based upon the quality of the existing wells.

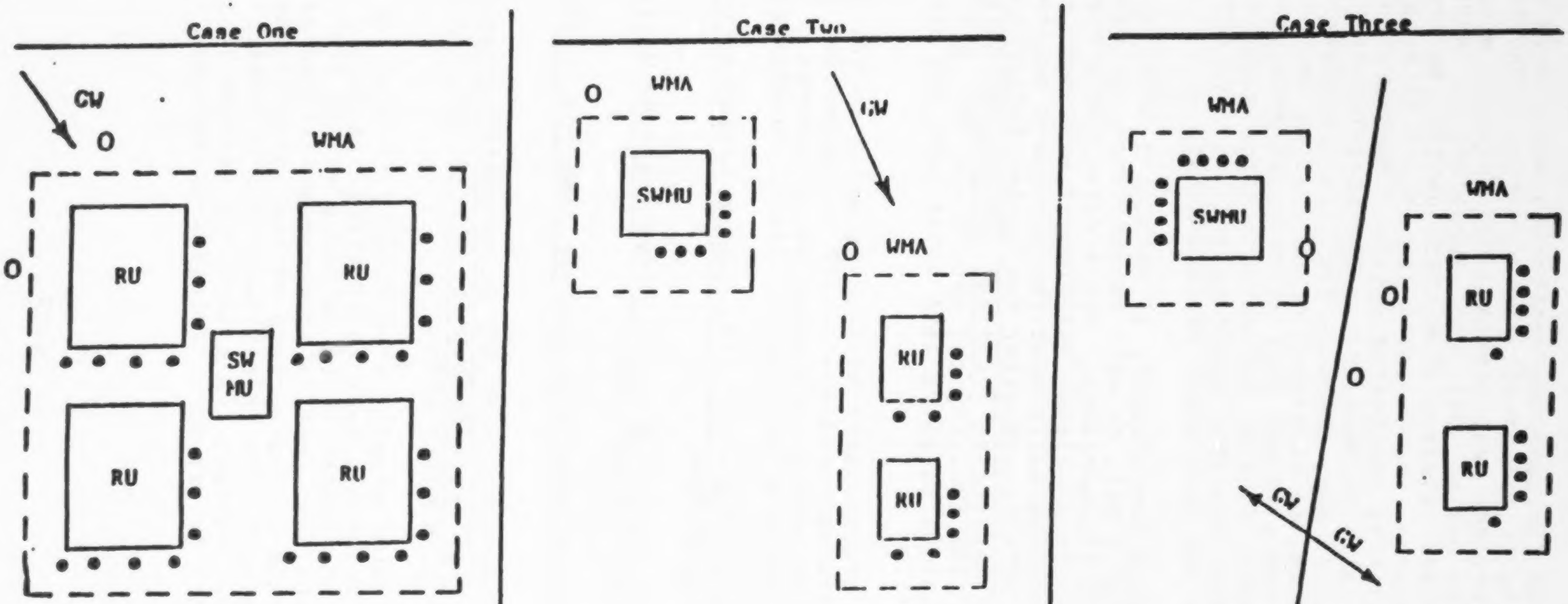
Sampling of ground-water monitoring wells in the RFA should be conducted by trained personnel. EPA has developed numerous guidance manuals on appropriate sampling procedures. These manuals may be consulted for specific field procedures:

- Ground Water Technical Enforcement Guidance Document Draft, August 1985
- RCRA Draft Permit Writer's Manual: Ground-Water Protection, October 1983
- Manual for Ground-Water Quality Sampling Procedures, 1981
- Revised Draft Protocol for Ground-Water Inspections at Hazardous Waste Treatment, Storage and Disposal Facilities, October 1985

The investigator should refer to Chapter Four for specific recommendations on QA/QC, chain-of-custody, safety, and decontamination procedures to be followed in the field. In general, the QA/QC and sampling procedures followed by the investigator should be appropriate to the intended use of the data. For example, if the investigator anticipates that the owner/operator may contest EPA's sampling results in court, it would be advisable to use more stringent procedures.

EXHIBIT 5-2

MONITORING WELL LOCATION


Case One
GW
O
WMA
RU
SW MU
Case Two
WMA
SWMU
GW
RU
Case Three
WMA
SWMU
GW
RU

Case One: No new wells may be needed for SWMU if all units are closely spaced.

Case Two: Wells for RUs not adequate for SWMU due to geographic remoteness.

Case Three: New wells needed for SWMU due to presence of a ground-water divide.

Key:

SWMU - Solid Waste Management Unit
RU - Regulated Unit
WMA - Waste Management Area
O - Background Monitoring Well
● - Downgradient Monitoring Well
GW → - Ground-Water Flow Direction

Note: Drawings not to scale.

The investigator should use best professional judgment in evaluating sampling results collected in the SV, based upon sound geologic and hydrogeologic principles. General guidance on evaluting sampling results is presented in Chapter Four.

B. Soil Sampling

The investigator may choose to sample soils at the facility in order to gain an understanding of the likelihood of a release to ground water. Many constituents, when released to soils, will further migrate into the surficial aquifer. The potential for migration to the ground water will depend upon the properties of the relevant constituents and the site geology (this is discussed in greater detail in Section II of this chapter). Soil sampling will be especially useful in situations where a facility lacks ground-water monitoring data or the ground water is deep.

Sampling locations should be chosen to provide the most useful information. For example, the investigator may want to determine whether constituents have migrated from a closed surface impoundment. Stratified sampling around the unit, and where possible, underneath the unit, may be helpful in detecting constituent concentration gradients indicative of migration. In other cases, the investigator may simply wish to confirm that a release incident occurred, such as a spill, by sampling the location where the suspected incident took place. Technical details on how to sample soils is provided in Chapter Eight of this guidance.

C. Soil Gas Monitoring

Soil gas monitoring can be used to detect the presence of volatile organic compounds (VOC's) in ground water and will be especially useful in cases where existing ground-water monitoring systems are inadequate to detect these contaminants. This technique, developed and used extensively by EPA's Environmental Response Team (ERT), detects the presence of VOC's in the unsaturated zone and provides a good indication of subsurface soil and/or groundwater contamination. In addition, this method can provide same-day results during a field investigation and will cost substantially less per sample than well drilling and GC/MS analysis.

Soil gas monitoring should be performed by trained personnel. The following document describes in detail standard procedures for conducting soil gas monitoring at waste sites:

> Lappala, E and G. Thompson, "Detection of Ground-Water Contamination by Shallow Soil Gas Sampling in the Vadose Zone Theory and Applications." *Proceedings of the Fifth National Conference on Management of Uncontrolled Hazardous Waste Sites*, Washington, D.C., 1984.

The following description of soil gas monitoring procedures is intended to assist the permit writer in recognizing those situations where its use would be appropriate, and to enable him/her to oversee its implementation by a contractor or the owner/operator.

When ground water or soils have been contaminated by VOC's, gaseous components of these compounds will be present in the interstitial pore spaces of the soil matrix, and are known as soil gas. By sampling the gas in this interstitial space and analyzing it for VOC's with a portable gas chromatograph in the field or in the laboratory with a GC/MS, the presence of soil and/or ground-water contaminants can be indicated.

First, the investigator must make a vertical hole in the soil through which the gas samples can be drawn. A hole can be made to a depth of five feet with a solid spring steel single piston slam bar (1.75m x 16.7 mm diameter). Threaded four foot sections can be added to the slam bar when holes deeper than five feet are desired.

After the hole has been made, the slam bar should be removed carefully to prevent the walls of the hole from collapsing. The investigator should then insert a stainless steel sampling tube into the hole. In order to prevent soil from clogging the sampling tube, a Teflon tube, slightly longer than the sampling tube, should be inserted into the sampling tube. The Teflon tube should be just wide enough to hold a small nail in its end, so that the nail head is wide enough to cover the end of the stainless steel sampling tube.

The sampling tube should be inserted into the hole, nail end first; when the sampling tube has been inserted to the desired depth, the Teflon tube can be removed, causing the nail to drop to the bottom of the hole. The sampling tube should then be removed 6 to 12 inches to ensure that soil gases will enter freely. Finally, top dirt should be packed around the tube to minimize iniltration of ambient air from the surface.

Soil gas will be pulled from the sample hole using a Gilian pump. ERT recommends evacuating five to seven gas volumes prior to sampling the hole. For a 1/4" hole about 10' deep and a pumping rate of three liters/minute, this evacuation should take about 15 seconds.

The gas in the well can be collected and sampled using three different methods. The simplest involves attaching a portable photoionization detector (e.g., HnU) to the stainless steel tube, using a short piece of Teflon tubing. The HnU provides indications of the total organic vapor concentration within the hole calibrated to a benzene standard. This method does not provide the investigator with information on individual compounds present in the soil, but may provide a sufficient indication of contamination to suggest the likehood of a release.

The HnU should be calibrated properly prior to use. A background reading of 1 to 2 ppm (as benzene) may result from soil moisture. Once the HnU reading has stabilized, usually after 45 to 60 seconds, the reading should be recorded.

Tedlar bags can also be used to collect soil gas for field analysis with a portable photoionization gas chromatograph (e.g., Photovac) or laboratory analysis with a cryogenic trapping capillary column gas chromatograph/mass spectrometer. The Tedlar bag should be filled with about 200-700 ml of vapor from the borehole, and analyzed within no more than 48 hours. This technique has the advantage that individual compounds may be detected, providing more detailed sampling data during the SV. One disadvantage involves uncertainties concerning the interaction of the Tedlar bag and the gas being collected. However, the quality of the data will be higher than that obtained using an HnU.

The most accurate technique for sampling and analysis will involve the use of sorbent tubes (e.g., Tenax, Chromosorb, etc.) to collect gas samples for laboratory analysis by GC/MS. Because contaminants collected on sorbent tubes maintain their integrity for a longer period (14 days) than those collected with Tedlar bags, it may be advantageous under some circumstances to use them to collect soil gas samples. The chief disadvantage of this technique involves the necessity of analyzing the samples in a laboratory, adding time and expense to the monitoring procedure.

Soil gas monitoring can be effective in detecting VOC's in soil gas which have a vapor pressure greater than xylene (5 mm Hg). Vapor pressures of a number of constituents of concern are listed in Appendix E for further reference. This monitoring technique does not provide a direct indication of the concentration of contaminants in ground water or soil. The relationship between soil and ground-water concentrations and soil gas concentrations will depend greatly upon the organic content of the soil and the octanol-water partition coefficient of the constituent of concern. The technique will provide the investigator with evidence of subsurface contamination, which will usually be sufficient to indicate the need for an RFI at the locations of concern.

D. Electromagnetic Conductivity Mapping

Geophysical techniques have gained acceptability in the last five years for the identification of waste releases to both ground water and soils, as well as for the sensing of buried wastes. This section briefly discusses one of these techniques, electromagnetic conductivity mapping (EM), which may be useful during the RFA.

EM surveys can provide an indication of ground-water contamination at sites with relatively simple, well-defined hydrogeologies (e.g., shallow, relatively uniform sand and gravel aquifers). This technique measures changes in the conductivity of the subsurface materials at a site, which may depend upon the composition of the subsurface soils, and/or the presence of dissolved contaminants in the ground water.

EM surveys provide iso-conductivity contours at a site, indicating the movement of contaminants from a source. While this technique does not provide information on either the types of constituents present, or their concentrations, it can provide indirect evidence of a release. However, it will primarily indicate only the presence of ionic constitutents in ground water.

Conducting EM surveys requires qualified personnel and expensive equipment, although it will be a relatively inexpensive method when using experienced contractors in the SV. This section does not provide technical information on how to perform an EM survey.

The investigator should be cautious when evaluating the results of an EM survey, due to the potential for interference from unusual geologic conditions at the site. Different geologic materials have different conductivities (e.g., moist clays have a higher conductivity than do dry sands). At facilities with complex hydrogeologic characteristics, the results of EM surveys could provide a false indication of contamination where non-homogeneities in the subsurface media reveal differences in conductivity. The difficulties associated with analyzing these data represent the major drawback to using this technique.

E. Sampling of Domestic Wells

In certain unusual cases, the investigator may choose to sample domestic wells in order to identify releases from the facility. This will be especially important when the investigator believes that a contaminant plume originating at the facility could pose an imminent threat to human health or the environment near the facility. Sampling data taken from domestic wells could provide sufficient evidence to suggest the need for immediate interim corrective measures at a facility (e.g., such as counter-pumping, or provision of an alternate drinking water supply).

Sampling residential water supplies could alarm affected residents. Because of this potential for community reaction, domestic wells should only be sampled when the investigator has strong evidence to suggest the presence of a threat.

When sampling domestic wells, it is important to run the water to remove any standing water within the distribution system. It is also important to take the samples prior to any in line treatment systems (e.g., water softeners).

F. Installation Of New Monitoring Wells

In unusual situations, EPA may find that new monitoring wells should be installed during the RFA in order to obtain useful ground-water data. While this should not be necessary at most facilities, it may be appropriate where ground-water data are wholly inadequate, where other sampling techniques do not provide sufficient information on the site, or if the owner/operator is recalcitrant and the investigator suspects that a release has occurred.

In most cases such as that presented above, the investigator should rely upon information collected during the RFA to demonstrate that a release may have occurred, and recommend that the facility conduct an RFI. However, this may not be possible when dealing with recalcitrant owner/operators. As a last resort, the investigator can recommend that new wells be installed.

Procedures for installing new wells should be based upon accepted hydrogeologic principles and best professional judgment. New wells should conform to standards described in the TEGD or Subpart F. Their locations should be chosen based on knowledge of site hydrogeology and best professional judgment.

IV. MAKING GROUND-WATER RELEASE DETERMINATIONS

The final task in the RFA process is to make determinations of release potential throughout the facility and to make recommendations for further action to address these potential releases. In making release determinations, investigators should evaluate the relevant information on unit characteristics, waste characteristics, site hydrogeology, and any evidence available from sampling and analytical data. Potential for exposure of receptors to contaminated ground water may also be a consideration in making conclusions for further action. If on the basis of the information and evidence available to the investigator, and his/her best professional judgment, it can be reasonably determined that there is, or is likely to be, a release of wastes or hazardous constituents to ground water which merits further investigation/characterization, or an immediate interim remedy, the owner/operator should be required in the RFI to conduct these necessary actions. It should often be possible, from the information gathered in the RFA, to be able to specify in some detail the nature of the investigations to be conducted; i.e., the area to be given further subsurface investigation, the constituents to be monitored for, the general area to be monitored for, and other elements of the ground water characterization program.

It should be understood that it is not necessary to prove in an RFA that ground-water contamination has occurred from SWMUs at a facility. Confirming the presence of a release will often be the initial phase of a follow-on RFI investigation.

Exhibit 5-3 is a checklist that should help the investigator evaluate specific factors to identify ground water releases and determine the relative effect on human health and the environment. In identifying releases, the investigator should consider the types of information presented in Exhibit 1-1, which are highlighted in this checklist.

Exhibit 5-3

Checklist for Ground Water Releases

Identifying Releases

1. Potential for Ground Water Releases

- Unit type and design
  - Does the unit type (e.g., land-based) indicate the potential for release?
  - Does the unit have engineered structures (e.g., liners, leachate collection systems, proper construction materials) designed to prevent releases to ground water?
- Unit operation
  - Does the unit's age (e.g., old unit) or operating status (e.g., inactive, active) indicate the potential for release?
  - Does the unit have poor operating procedures that increase the potential for release?
  - Does the unit have compliance problems that indicate the potential for a release to ground water?
- Physical condition
  - Does the unit's physical condition indicate the potential for release (e.g., lack of structural integrity, deteriorating liners, etc.)?
- Locational characteristics
  - Is the facility located on permeable soil so the release could migrate through the unsaturated soil zone?
  - Is the facility located in an arid area with less infiltration of rainwater and therefore with less potential for downward migration of any release?
  - Does the distance from a unit or area to the uppermost aquifer indicate the potential for release (e.g., the waste lies within the aquifier)?
  - Does the rate of ground water flow greatly inhibit the migration of a release from the facility?
  - Is the facility located in an area that recharges surface water?

Exhibit 5-3 (continued)

Checklist for Ground Water Releases

- o Waste characteristics
  - Does the waste exhibit high or moderate characteristics of mobility (e.g., tendency not to sorb to soil particles or organic matter in the unsaturated zone)?
  - Does the waste exhibit high or moderate levels of toxicity?
  - Does the waste exhibit hazardous characteristics (e.g., lower high pH)?

2. Evidence of Ground Water Releases

- o Existing ground-water monitoring systems
  - Is there an existing system?
  - Is the system adequate?
  - Are there recent analytical data that indicate a release?
- o Other evidence of ground water releases
  - Is there evidence of contamination around the unit (e.g., discolored soils, lack of or stressed vegetation) that indicates the potential for a release to ground water?
  - Does local well water or spring water sampling data indicate a release from a facility?

Determining the Relative Effect of the Release on Human Health and the Environment

1. Exposure Potential

- o Conditions that indicate potential exposure
  - Are there drinking water well(s) located near the facility?
  - Does the direction of ground water flow indicate the potential for hazardous constituents to migrate to drinking water wells?
  - Does the ground water discharge to a surface water body with recreational use or that supports fish or any endangered species?

CHAPTER SIX

SURFACE WATER

I. INTRODUCTION

A. Purpose

This chapter provides technical information to support the investigation of SWMU and other releases to surface water during the RFA. While Chapters Two, Three, and Four provide general guidance on conducting RFAs, this chapter focuses on specific factors unique to the surface water media that should be considered by the investigator.

This chapter has been organized to reflect the separate phases of the RFA process:

- o Conducting a preliminary review of existing information related to releases to surface water;
- o Inspecting the facility to obtain evidence of release;
- o Collecting additional sampling information in the SV; and
- o Making final release determinations.

The first section describes the technical factors that should be considered during the PR and VSI. The second section describes the technical approach to obtaining additional sampling information in the SV for surface water, and should be consulted along with Chapter Four on conducting a SV. The final section discusses factors to consider when making release determinations to surface water at the end of the RFA. This section also discusses the options for further investigation to be evaluated at the end of the RFA for surface water releases.

B. Scope

The investigator should evaluate all RCRA facilities for releases to surface water that pose an actual or potential threat to human helath and the environment. These releases may include surface water discharges permitted or required to be permitted under the NPDES program. In these cases, the investigator should attempt to make an initial characterization of the potential problem. However, he/she should usually refer the further investigation and control of these discharges to the NPDES permitting authority, rather than addressing them through RCRA authorities [§3008(h), §3004(u), or §3004(v)]. EPA is developing more specific guidance on how to make these referrals.

In most cases surface water investigations will relate to run-off from specific SWMUs. However, there may be situations where general facility run-off may be impacting human health and the environment. The 3008(h) corrective action authority allows the investigator to address these situations.

II. CONDUCTING A PRELIMINARY REVIEW AND VISUAL SITE INSPECTION OF RELEASES TO SURFACE WATER

This section presents technical information related specifically to the surface water pathway to be considered when conducting the PR and VSI. Accordingly, this section has been organized to reflect the primary goals of these steps as described in Chapters Two and Three:

- Identifying and describing potential threats to surface water at RCRA facilities; and
- Making a preliminary assessment of the need for a SV or other actions at these facilities.

This section reflects the importance of the RFA information matrix (Exhibit 1.1) for evaluating the likelihood of releases to surface water in the PR. It describes each of the five types of information described in this matrix as it applies to the surface water pathway. In addition, this section provides technical information to help the investigator determine when additional sampling will be necessary in a SV to identify surface water releases. The factors discussed are as follows:

(1) Unit characteristics;

(2) Waste characteristics;

(3) Pollutant migration pathways;

(4) Evidence of release;

(5) Exposure potential; and

(6) Determining the need for additional sampling information.

This information will be relevant to the evaluation of written documents in the PR and information gathered during the VSI. Consult Chapters Two and Three for general guidance on conducting PAs and VSIs.

A. Unit Characteristics

The design and operating characteristics of a SMWU will determine to a great extent its potential for releasing hazardous constituents to surface water. Many treatment, storage, and disposal units are designed to prevent releases to the environment.

The investigator should evaluate the unit characteristics of each SMWU or group of SWMUs at a facility to determine their potential for releasing hazardous constituents to surface water.

As with the other media, the likelihood that a SWMU has contaminated surface water or a surface water drainage pathway is largely dependent on the nature and function of the unit. For example, open units that contain liquids (e.g., surface impoundments) have a greater potential for release than closed landfill cells that have been properly capped.

Exhibit 6-1 loosely ranks commonly observed SWMUs in a descending order on the basis of their potential for having releases that may cause surface water contamination. It is intended to provide a general sense of the relative potential for units to cause these types of releases. The investigator will also need to evaluate unit-specific factors in determining the potential for release from a particular unit.

The major unit-specific factors the investigator should evaluate are discussed below.

1. Unit design

The investigator should determine whether the unit has engineered features (e.g., run-off control systems) that are designed to prevent releases from the unit. If such features are in place, the investigator should evaluate whether they are adequate (in terms of capacity, engineering, etc.) to prevent releases. A landfill, for example, may have berms to control run-off, but the berms may not be adequate to contain run-off during periods of peak rainfall. In addition, a surface impoundment or open tank with insufficient freeboard may not be able to prevent overtopping that could occur because of wave action during storm events.

2. Operational history

During the PR and VSI, the investigator should examine the unit's operating history to obtain information that indicates releases have taken place. There are several operational factors that influence the likelihood of release.

- Operating life of the unit. Units that have been operating for long periods of time are generally more likely to have releases than new units.
- Operating status of the unit. In some cases, the operating status of a unit (e.g., closed, inactive, etc.) may have an effect on the relative likelihood of release.

EXHIBIT 6-1

RANKING OF UNIT POTENTIAL FOR SURFACE WATER RELEASE AND MECHANISMS OF RELEASE

Unit Type	Release Mechanism*
Surface Impoundment	o Releases from overtopping
	o Seepage
Landfill	o Migration of run-off outside the unit's run-off collection and containment system
	o Migration of spills and other releases outside the containment area from loading and unloading operations
	o Seepage through dikes to surrounding areas (e.g., soils, pavement, etc.)
Waste Pile	o Migration of run-off outside the unit's run-off collection and containment system
	o Migration of spills and other releases outside the containment area from loading and unloading operations
Land Treatment Unit	o Migration of run-off outside the containment area
Container Storage Area	o Migration of run-off outside the containment area
Above-ground Tank	o Releases from overflow
	o Leaks through tank shell
	o Spills from coupling/uncoupling operations
In-ground Tank	o Releases from overflow
	o Spills from coupling/uncoupling operations
Incinerator	o Spills or other releases from waste handling/preparation activities
	o Spills due to mechanical failure
Class I and IV Injection Well	o Spills from waste handling operations at the well head

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* The two remaining solid waste management units; waste transfer stations, and waste recycling operations generally have mechanisms of release similar to tanks. All units may release to ground water when the surface water at the facility is hydrogeologically connected to it.

- o Operating procedures. Maintenance and inspection records should indicate whether a unit is likely to have released. Units that are inspected regularly and properly maintained are less likely to have releases than units that have been poorly maintained.

3. Physical condition of the unit

During the VSI, the investigator should examine the units for evidence of releases or characteristics that could cause releases. For example, when inspecting a surface impoundment, the investigator should determine whether the earthen dikes are structurally sound to prevent releases. Cracks, slumping or seeps around the toe in these dikes may cause releases to the surface water drainage pathway.

B. Waste Characteristics

The investigator should attempt to identify the wastes originally contained within a SWMU or group of SWMUs during the PR. In the PR, the investigator will try to connect information on waste types, the surface water drainage pathway, and evidence of surface water, sediment, or soil contamination to demonstrate the likelihood that specific SWMUs, groups of SWMUs, or other areas have released constituents to the surface water. This section describes technical factors to consider when identifying waste characteristics relevant to surface water releases. It also discusses physical/chemical properties that will affect the release potential of wastes and their subsequent transport in the surface water drainage pathway.

Information on constituents and their properties can aid the investigator in identifying migration pathways of concern and sampling locations in environmental media. For example, knowing that the waste primarily contains heavy metals, which have a tendency to precipitate and settle, the investigator can look for evidence of a release in the sediments around the point of discharge into a river and plan on taking samples of the bottom sediment.

Constituents, depending on their properties, will tend to migrate in different forms and at different rates in the pathway. Some constituents, which are highly soluble, will dissolve in water and be transported within the water column. Insoluble constituents can be transported into surface water by suspension from turbulent run-on/run-off. Other generally insoluble waste constituents are lighter than water and will be transported on the surface, forming oily sheens. Hazardous metals and inorganics (e.g., arsenic and cyanides) may be relatively mobile in water, depending upon the pH of the wastes and the surface water, the oxidation-reduction potential of the surface water (this will be most important in the lower layers of deeper lakes), and the ligands present for complex formation. Hard surface water, due to the presence of higher concentrations of carbonate ions, will support the formation of relatively immobile metal complexes. These metal complexes form precipitates, which will settle out with sediment.

The tendency of organic constituents to adsorb to soils can be expressed quantitatively by the sorption equilibrium coefficient (K_d). The value of K_d depends upon the organic content of the suspended sediments and the constituent-specific soil adsorption coefficient (K_{oc}). Constituents sorbed onto soil and sediment particulates may enter the surface water pathway as suspended materials in run-off.

The investigator will seldom have access to information on organic content of soils and sediments at a facility; instead it will be more useful to estimate the relative mobility of a constituent as expressed by k_{oc}. Few k_{oc} values have been estimated for specific constituents; however, the octanol-water coefficient, (K_{ow}), can be used as an indicator of K_{oc}. Appendix E presents K_{oc} and log (K_{ow}) values for many constituents of concern. Because these are log values, chemicals with K_{ow} values of more than two can be considered relatively immobile; these constituents will usually settle in stream sediments.

The water solubility of constituent chemicals can be obtained from several chemical handbooks (e.g., Handbook of Chemistry and Physics, CRC Press). Many water soluble chemicals (e.g., phenol, dimethylamine) are also readily biodegradable by the numerous organisms indigenous to surface water. This characteristic will make it difficult to identify past releases of these chemicals.

In addition, knowledge of constituent properties can provide information on the potential for intermedia transfers from surface water to other media. For example, if a waste source contains a high percentage of VOCs, the investigator may be concerned that releases to surface water will volatilize and result in an air release. Intermedia transfers may also occur to soils, and ground water from the surface water pathway. The user should refer to individual media-specific chapters for guidance on investigating releases to these media.

C. Pollutant Migration Pathways

The investigator should evaluate any available information pertaining to the surface water drainage pathway at a facility in order to determine the pollutant migration pathways associated with surface water releases during the PR. This information will play a major role in identifying surface water releases at a facility.

In cases where the investigator finds little direct evidence of a release to surface water (e.g., direct evidence of overtopping from a surface impoundment onto soils), he/she should make deductions on the likelihood of release by linking information on waste characteristics, the pollutant migration pathway, and indirect evidence of release (e.g., environmental sampling data showing contamination of surface water, soils in drainage pathways, or stream sediments). It will be easier to demonstrate that a contaminant originated at a particular SWMU when the investigator can show that, based on the characteristics of the surface water drainage pathway, a release from the particular SWMU would be likely to result in the observed contamination.

In characterizing surface water release pathways, the investigator should identify any drainage pathway(s) leading from the unit of concern to surface water. Topographic maps provide information on the slope of the intervening terrain between the units of concern and downgradient surface water, which is helpful in determining the route run-off follows to surface water. These maps may also help in locating surface water bodies.

Upon entering surface water, the transport of the constituents in the surface water pathway is highly dependent on the type of surface water body. The three major classifications of surface water are: rivers and streams, impoundments (e.g., lakes, bays, etc.) and estuaries (including wetlands).

Contaminants entering rivers and streams will tend to be transported downstream. However, as discussed earlier, heavy metals are likely to settle out with sediment. Also, VOCs entering a turbulent stream may volatilize into the air.

Constituents entering impoundments or estuarine systems will tend to pollute areas near their discharge points because these water bodies are relatively slow moving and are not likely to transport the constituents significant distances.

The investigator also should look for any effect that permitted discharges (e.g., NPDES, dredge or fill) may have on environmental pathways. For example, a NPDES discharge may be releasing RCRA constituents not covered by the permit, causing downstream contamination. In addition, the investigator should consider the possibility that waste in NPDES units or in other permitted discharges may be releasing to ground water or air.

Finally, the investigator should consider possible intermedia transfers to surface water. He/she should consider the potential for releases from soil and/or ground water (ground water discharge) to affect the surface water pathway.

In sum, the investigator should use his/her knowledge of the constituents in the waste, the drainage patterns leading from the unit to surface water, and the effect of different surface water bodies on the transport of various constituents, to identify areas to look for evidence of release. He/she should also use this knowledge to specify appropriate sampling points.

D. Evidence of Release

The investigator should examine any available sources of information to identify evidence that constituents have been released to the surface water at a facility. The investigator should evaluate both direct and indirect evidence of release collected during the PR. General considerations on how to look for evidence of release are discussed in Chapters Two and Three.

Direct evidence of release to surface water may include official reports of prior release incidents, such as a major tank car spill to the ground or documentation that a surface impoundment has released to surface water. Indirect evidence will usually entail information from surface water quality monitoring data, including visual observations of aquatic stress (e.g., fish kills) from water contamination. When the investigator identifies indirect evidence of this type, it may be necessary to determine its source at the facility by evaluating the pollutant migration pathways and the waste characteristics at the facility.

The investigator should examine available sources of information and use recent visual observations obtained during a site inspection to identify any evidence that hazardous constituents have released from SWMUs at the facility to surface water.

NPDES files are particularly useful in identifying historical releases to surface water or determining the likelihood of current releases. NPDES personnel that are familiar with the facility can often obtain information on past releases. Other key sources of information include: RCRA inspection reports, CERCLA reports (e.g., PA/SI), and discussions with the State agency responsible for fisheries and wildlife management.

Due to the intermittent nature of many surface water releases, the VSI is particularly important. The investigator should examine the site and nearby surface water for physical evidence of release and focus on trying to obtain evidence of releases in areas between the unit and the closest surface water body. The investigator should look for visible evidence of uncontrolled run-off. If releases have occurred or are occurring at a unit, there is likely to be evidence around the unit that indicates a release is taking place. In addition, if the facility is located adjacent to surface water, the investigator should examine the surface water for evidence of releases. During the VSI, the investigator should look for:

- Observable contaminated run-off or leachate seeps;
- Drainage patterns that indicate possible run-off from units at the facility;
- Evidence of wash-outs or floods, such as highly eroded soil, damaged trees, etc.;

- Discolored soil, standing water, or dead vegetation along drainage patterns leading from the unit;
- Discolored surface water, sediment or dead aquatic vegetation;
- Evidence of fish kills;
- Unpermitted point source discharges;
- Units (including old fill material that is now considered hazardous waste) discharging in surface water; and
- Permitted discharges that are of concern. e.g., downstream contamination resulting from permitted discharges; release of RCRA constituents to surface water; NPDES units/discharges causing contamination problems in other media (e.g., air, ground water).

E. Exposure Potential

The investigator should evaluate available information on the location, number, and characteristics of potential receptors that could be affected by surface water releases at the facility. These receptors include human populations, animal populations (particularly any endangered or protected species), and sensitive environments.

Potential receptor information will be used primarily in helping the investigator determine the need for interim corrective measures at the facility in order to address instances of surface water contamination posing especially high risks of exposure.

The investigator should evaluate the likelihood for receptors to be exposed to hazardous constituents through releases to surface water in order to assess the severity of release. If receptors are currently being exposed to a release or have a high potential for being exposed, then the investigator should consider recommending immediate corrective measures (e.g., run-off control measures) to limit or eliminate exposure to the release.

The types of information that are useful in evaluating the potential for human and environmental receptors to be exposed to surface water releases are discussed below.

1. Human receptors

Human receptors can be exposed to the release via their use of surface water. The investigator should determine the use(s) of the surface water body of concern (e.g., no use, commercial or industrial, irrigation, fisheries, commercial food preparation, recreation, or drinking). A release is more likely to significantly impact human health if the surface water is being used as a source of contact recreation (e.g., swimming) rather than being used for industrial or a commercial purposes. Information on the location of any drinking or irrigation water intakes is usually listed in public records, which may be obtained from the local health department.

2. Environmental receptors

Constituents in a release to surface water may contact sensitive habitats (e.g., a highly productive biological community, or a habitat of rare or endangered plants or animals). The investigator should locate any sensitive habitats in the surface water pathway. This information can generally be obtained by talking with State Fish and Wildlife Management Agencies and local environmental groups. In some cases, reports such as environmental impact studies have been prepared for the area.

F. Determining the Need for Additional Sampling

In the surface water medium, investigators may often find that existing data on a release from a unit is unavailable or insufficient. In cases where historical information and visual observations are not adequate to determine if a surface water release from a unit has occurred or is likely to have occurred, he/she should consider whether additional sampling and analysis would help in making a determination. In this section, we present:

- General information on factors to consider in determining the need for additional sampling information;
- Factors to consider in selecting sampling parameters; and
- An example to illustrate this discussion.

1. General Information on Determining The Need for Sampling

The following are example situations where additional analytical data would be helpful in determining if a release has occurred:

- During visual inspections, indirect evidence of a release (e.g., oil slicks, foam) have been observed, and chemical analysis may identify the unit causing the release; and
- Existing surface water monitoring data or available information suggest a release, and more data will either confirm the release and/or identify the unit of concern.

2. Selection of Sampling Parameters

Knowledge of the wastes that may be potentially released from a unit is the starting point when identifying sampling parameters. However, many SWMUs have incomplete or no data on the wastes deposited over time. When little is known of the wastes managed in the unit, gas chromotography/mass spectrometry (GC/MS) scans such as acid extractables or base/neutral extractables become a good starting point when selecting parameters for analysis in surface water and sediments.

When a waste source is hazardous due to EP Toxicity, the metals of concern are arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The following metals precipitate readily under many naturally occurring conditions and can be found in sediment analysis: cadmium, lead, nickel, and zinc.

The volatile GC/MS scan identifies chemicals that are chararteristic of solvents and lighter petroleum products (e.g., gasoline). Many of these compounds are readily found in the environment from releases from various waste sources. Because they are very volatile, and surface water bodies (particularly rivers and streams) have the capacity to release these constituents via evaporation into the air, evidence of these chemicals may be very difficult to obtain. It is not recommended to analyze surface water bodies for these constituents unless a release is current or on-going. Leachate samples and run-off, if available, are more ammenable to retaining evidence of volatile constituent releases.

Acid extractable compounds may be present in heavier petroleum feedstocks, and certain industrial processes (e.g., pentachlorophenol from wood preserving). Some of those compounds (e.g., phenol, pentachlorophenol, 2-chlorophenol) are present in common waste sources, including POTW discharges. Phenol and the mono-halogenated phenols biodegrade readily in most soil and surface water environments.

Base/neutral compounds can often be found in wastes from industries such as plastics and synthetic fibers manufacturers. The pesticide scan identifies pesticides that are found specifically in pesticide wastes and products from the agrichemical industry.

When collecting surface water and sediment samples, it may be valuable to sample an up-stream site for the same chemical parameters that will be analysed in the area of the suspected release. There will often be a high potential for other waste sources (e.g., POTWs, industrial NPDES discharges) to contaminate surface waters with the same constituents under investigation in the RFA.

3. Example

An illustration of a situation in which sampling would be called for is as follows: A waste pile of thickened and filtered wastewater treatment sludges from an electroplating operation has been stockpiled on a cement pad for almost ten years. Visual inspection of the waste pile shows that there are no on-site controls to prevent run-on and run-off. In fact, channels are observed leading downgradient from the pile, reaching a medium sized stream about 200 yards away.

The waste pile contains both copper and nickel from the electroplating process. The sludge was formed by the treatment of wastewaters containing copper cyanide and nickel cyanide by the addition of lime to form insoluble precipitates. Analysis of current sludge samples shows significant levels of cyanide. There is no data on the cyanide levels in the ten year old waste pile. There is no water quality data from the stream on the parameters of interest (e.g., copper, nickel, or cyanide). Fish kills were reported on the stream eight or more years ago. There have been no recently documented fish kills.

In this scenario, the investigator should probably call for sampling to find constituent-specific evidence of a release to surface water. Cyanide, being mobile in water, is anticipated to be leached out of the waste pile and dispersed down stream during storm events. Any evidence of a release must be preserved in the soil and sediment. Therefore, the sampling program centers around copper and nickel analysis in the soils and sediments. Soil sampling is recommended for the low spots in the drainage where run-off may have formed puddles.

The investigator should take sediment samples of the stream bottom, and analyze them for copper, nickel, and cyanide. Because cyanide is soluble and degradable in small quantities in the sediments and soils, it may not be found in the sediments or remain in the water. Because of the high cost and delay associated with analyzing sampling results, the investigator may attempt to limit the selection of sampling parameters to those most likely to result in an identification of a release.

III. COLLECTING ADDITIONAL SAMPLING INFORMATION IN THE SV

This section presents technical information related specifically to the surface water pathway to be considered when collecting additional sampling information in the SV. Accordingly, the information presented here should be used to help the investigator meet one of the primary goals of the SV:

- To collect additional sampling information to fill data gaps identified in the PR and SVI.

For each sampling method discussed, this section describes: 1) the general kinds of situations in which it will be appropriate to employ a specific technique, 2) technical information on how to conduct the sampling, and 3) specific details to be considered when evaluating the sampling results. This section does not provide the actual SOPs on sampling techniques, but references relevant manuals.

The choice of appropriate sampling methods will have a large impact on the cost and usefulness of the SV. The investigator should be confident when developing and reviewing the sampling plan that the procedures chosen will meet the needs of the RFA, while not resulting in the collection of unnecessary data. This section discusses the following four sampling methods which may be of use:

(1) Surface water sampling;

(2) Sediment sampling;

(3) Soil sampling; and

(4) Run-off sampling.

A. Surface Water Sampling

It is important to select sampling locations for surface waters prior to actual sample collection since location will often affect the choice of sampling equipment. Selection of sampling location depends on surface water body type (e.g., pond or stream), flow rate, depth, and width. In practice, safety and physical access limitations will often affect sample locations.

Surface water samples can be collected directly by submerging the sample bottle. However, it is preferable to use a sample collection container (e.g., beaker), properly cleaned and of appropriate material, to avoid contaminating the outside of the bottle used to transport the sample back to the laboratory.

It is often necessary to collect samples away from the shore. If a plume is visible, samples should be taken within the plume. A telescoping aluminum pole with an adjustable beaker clamp attached to the end is the easiest device to use to reach sampling locations several feet off-shore. The collection vessel or the sample bottle is held by the clamp. Samples can be transferred to appropriate bottles for shipment back to the laboratory. Surface water samples should be preserved and cooled to $4^{o}C$ prior to shipment to the laboratory. The laboratory may provide the preservatives within the bottles. These cannot be used for direct sampling.

B. Sludge and Sediment Sampling

Sediment or sludge can usually be sampled by using a stainless steel scoop or trier. Where sediment has a shallow liquid layer above it, it may be scooped by a pond sampler or preferably with a thin-tube sampler. This device is preferred because it causes less sample disturbance and will also collect an aliquot of the overlying liquid, thus preventing drying or excessive sample oxidation before analysis.

If the sludge layer is shallow, less than 30 centimeters, corer penetration may damage the container liner or bottom. In this case, a Ponar or Eckman portable dredge can be used since these samplers can generally only penetrate a few centimeters. Of the two samplers, Ponar grab samplers can be applied to a wider range of sediments and sludges. They penetrate deeper and seal better than the spring-activated Eckman dredges, especially in granular substrates.

When sampling, the investigator should consider a number of additional factors. For instance, because streams, lakes, and impoundments generally demonstrate significant variation in sediment composition resulting from distance from inflows, discharges, or other disturbances, the investigator should document exact sampling locations by means of triangulation with stable references on the banks of the stream or lake. In addition, the investigator may have to modify or not use some devices described above if rocks, debris and organic material in the sediment complicate sampling.

EPA's publication, Characterization of Hazardous Waste Sites-A Methods Manual: Volume II. Available Sampling Methods, Second Edition, pages 2-8 to 2-18, describe these sampling techniques in greater detail.

C. Soil Sampling

If run-off or leachate samples cannot be obtained directly (e.g., lack of precipitation), soil samples can be taken within gullies or other run-off channels to identify contamination. Results showing contaminated soil in a run-off pathway will indicate the potential for a surface water release. Constituents found in drainage pathways may confirm the presence of contaminated run-off. The identification of a release to soils and the appropriate sampling protocol is covered in Chapter Seven, Soils.

D. Run-off Sampling

Sampling of run-off and leachate seepage involves several technical difficulties and will be less common in the RFA. The major criteria used to determine how and where to sample include: obtaining a representative sample, safety of the personnel conducting the sampling, and the timing of sample collection with the high precipitation necessary to create run-off or infiltration and seepage. Lack of precipitation during the sampling program is the major obstacle to obtaining run-off samples.

Due to the differences in run-off patterns between facilities, no one sampling method is considered reliable for obtaining a representative sample at every location. The investigator will need to use professional judgment when designing site-specific sampling plans. When sampling sheet run-off or small leachate streams, a weir may be used to enable the liquid to spring free of the surface to provide a sufficient volume for the parameter analysis. These samples should be collected as grabs and all parameters should be taken within a short period of time (i.e., less than 15 minutes).

The best method for manually collecting samples is to use the actual sample container that will be used to transport the sample to the laboratory. This will prevent the contamination of samples by the use of a collection device. The collection container should be properly cleaned.

Samples for oil and grease analysis should be collected directly from the run-off. The investigator should avoid using collection vessels when transferring oil and grease samples since oil residue will adhere to the vessel and may not be transferred with the sample to the container.

Care should be taken to avoid collecting leaves and debris in the vessel. The sample can then be transferred to the appropriate container. Some laboratories will add the preservatives directly to the sample containers and other laboratories will have the sampling team preserve the samples. The investigator should use appropriate methods to preserve run-off samples. Leachate samples, which are generally considered to be hazardous samples rather than environmental samples, should not be preserved. SW 846, Test Methods for Evaluating Solid Waste - Physical Chemical Methods is the best reference for hazardous samples. Methods for Chemical Analysis of Water and Wastes is a good reference for preservation techniques for run-off samples.

In evaluating results, it is very important to determine if representative samples were obtained and appropriate sampling methods were used to collect parameters. QA/QC protocol for sampling is described in Chapter Four.

IV. MAKING SURFACE WATER RELEASE DETERMINATIONS

This section summarizes information that the investigator should consider when making release determinations in the surface water pathway.

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IV. MAKING SURFACE WATER RELEASE DETERMINATIONS

This section summarizes information that the investigator should consider when making release determinations in the surface water pathway.

Chapter Four presents the general procedure to be followed when making release determinations in the RFA. This involves:

- Evaluating sampling results from the SV;
- Integrating facility information gathered in the PR, VSI, and the SV;
- Determining the likelihood of release at the facility; and
- Making recommendations concerning the need for further investigations.

The investigator should rely upon information available and his/her best professional judgment when making release determinations in the surface water pathway. As stated in Chapter Four, it will often be necessary to make deductions on the likely origins of surface water contamination in the RFA when there is evidence of such contamination. In order to do this, the investigator should be able to demonstrate that: 1) the constituents identified in the surface water or sediments were present in the specific unit or group of units; and 2) the pollutant migration pathways at the site support a determination that a constituent leaking from a specific unit or group of units would be likely to migrate to the surface water of concern. The investigator should rely upon best professional judgment in making this determination.

Further investigations to establish the presence of, and character of, surface water (and/or sediment) contamination problems, and the sources of such contamination, should be required of the owner/operator when information or evidence indicates that there is or is likely to be releases from the facility to the surface water body which poses an actual or potential threat to human health or the environment.

Exhibit 6-2 is a checklist that should help the investigator evaluate specific factors to identify surface water releases and determine the relative effect on human health and the environment. In identifying releases, the investigator should consider the types of information presented in Exhibit 1-1 which are highlighted in this checklist.

EXHIBIT 6-2

Checklist for Surface Water Releases

- Unit Design and Physical Condition
  - Are engineered features (e.g., run-off control systems) designed to prevent releases from the unit)?
  - Does the operational history of the unit indicate that a release has taken place (e.g., old, closed or inactive unit, not inspected regularly, improperly maintained)?
  - Does the physical condition of the unit indicate that releases may have occurred (e.g., cracks or stress fractures in tanks or erosion of earthen dikes of surface impoundments)?
- Release Migration Potential
  - Does the slope of the facility and intervening terrain indicate potential for release?
  - Could surface run-off from the unit reach the nearest downgradient surface water body?
  - Is the intervening terrain characterized by soils and vegetation that allow overland migration (e.g., clayey soils, and sparse vegetation)?
  - Does data on one-year 24-hour rainfall indicate the potential for area storms to cause surface water or surface drainage contamination as a result of run-off?

EXHIBIT 6-2 (cont.)

Checklist for Surface Water Releases

- Waste Characteristics
  - Is the volume of discharge high relative to the size and flow rate of the surface water body?
  - Do constituents in the discharge tend to sorb to sediments (e.g., metals)?
  - Do constituents in the discharge tend to be transported downstream?
  - Do waste constituents exhibit moderate or high characteristics of persistence (e.g., PCBs, dioxins, etc.)?
  - Do waste constituents exhibit moderate or high characteristics of toxicity (e.g., metals, chlorinated pesticides, etc.)?
- Evidence of Release
  - Is there direct evidence (e.g., sampling data; observed contaminated run-off)?
  - Is there indirect evidence (e.g., discolored soil, dead vegetation)?

CHAPTER SEVEN

AIR

I. INTRODUCTION

A. Purpose

This chapter provides technical information to support the investigation of air releases during the RFA. While Chapters Two Three, and Four provide general guidance on conducting an RFA, this chapter focuses on specific factors unique to the air medium that should be considered by the investigator.

In investigating the potential for air releases during the RFA, the investigator should focus his/her attention on operating units. Operating waste management units have the greatest potential for air releases because they actively expose wastes to the air on a continuous basis. In investigating air releases, EPA personnel should take safety precautions in order to reduce their exposure to on-site emissions. Safety precautions are discussed in Chapter Four.

Wastewater treatment units, such as those in treatment trains regulated by NPDES, can cause significant volatile air emissions. The investigator should address potential air releases from these units in the RFA.

This chapter is organized to reflect the separate phases of the RFA process:

- o Conducting a preliminary review of existing information;
- o Conducting a visual site inspection;
- o Collecting additional sampling information in a SV; and
- o Making release determinations.

The first section describes the technical factors that should be considered during the PR and VSI. The second section describes the technical approach to obtaining additional sampling information in the SV for air, and should be consulted along with Chapter Four on conducting a SV. The final section discusses factors to consider when making air release determinations at the end of the RFA. This section also presents options for further investigation of air releases to be evaluated at the end of the RFA.

II. CONDUCTING A PRELIMINARY REVIEW AND VISUAL SITE INSPECTION OF AIR RELEASE POTENTIAL

This section presents technical information related specifically to the air pathway to be considered when conducting the PR and VSI. Accordingly, this section has been organized to reflect the primary goals of these phases of the RFA described in Chapters Two and Three:

- Identifying and describing potential threats to air at RCRA facilities; and
- Making a preliminary assessment of the need for a SV or other actions at these facilities.

This section presents technical information specific to the air pathway covering the five types of information described in Exhibit 1-1, and technical information to help the investigator determine when additional sampling will be necessary in a SV to identify air releases. We will discuss these six types of information separately:

(1) Unit characteristics;

(2) Waste characteristics;

(3) Pollutant migration pathways;

(4) Evidence of release;

(5) Exposure potential; and

(6) Determining the need for additional sampling information.

This information is relevant to the evaluation of written documents in the PR and information gathered in the VSI.

A. Unit Characteristics

The design and operating characteristics of a SWMU will determine to a great extent their potential for releasing hazardous constituents to air. While the investigator should evaluate all SWMUs for air releases, including NPDES units, the investigation should focus on operating units. As previously mentioned, operating units have the greatest potential for air releases because they actively expose wastes to the air on a continuous basis. Wastes in closed, inactive units will have a lower potential to cause air releases. There may be some exposure to the air if a cover has eroded or broken down, but air releases resulting from these situations are likely to be negligible (i.e., undetectable).

When assessing the potential for releases, the key factors to examine include:

- Unit size. The size of a unit determines the mass of potential contaminants available for release. Volatilization rates are likely to be larger from open units (e.g., surface impoundments and open tanks) with large surface areas.

- Purpose of the unit (treatment, storage, or disposal). In general, units in which active treatment is occurring have the greatest potential for air releases. In many cases, treatment is designed to promote volatilization of constituents. In other cases, this is not the main purpose of the treatment method in use. However, the resultant mixing and movement of wastes leads to high volatilization rates.

- Design of the unit. Units in which wastes are in direct contact with the atmosphere have a higher potential for releases than closed or covered units.

- Current operational status. The nature of air releases is such that the majority of the mass available for release will be released shortly after the waste is placed in the unit. Thus, as mentioned, operating units are of greater concern than closed units. This is particularly true for unit types and wastes for which volatilization is important. Units with potential particulate releases may continue to release contaminants well after closure, especially if the unit has been poorly maintained.

- Unit specific factors. There are specific design and operational factors associated with each unit type which are useful in evaluating the potential for release. These factors are summarized in Exhibit 7-1.

In addition to considering the individual unit sizes, the investigator should be aware of the total area used for solid waste management at a facility. Although individual units may have undetectable releases, the total release from a facility can be significant. Exhibit 7-1 lists specific considerations for particularly important unit types.

In assessing a unit's potential for air release, the investigator should be aware of the importance of interactions between the various unit characteristics listed above and the characteristics of the wastes placed in the unit. It is important to examine how these two factors combine to result in an air release. For example, a facility may have several large operating surface impoundments, suggesting a potential for large air releases. However, if the facility is a steel manufacturer treating only spent pickle liquor in these ponds, it is unlikely any air release will occur because the hazardous constituents in the waste are non-volatile, soluble metals.

EXHIBIT 7-1

UNIT POTENTIAL FOR AIR RELEASES AND MECHANISMS OF RELEASE

Unit Type	Characteristics and Mechanisms of Release
Operating Surface Impoundments	o Wastes directly exposed to atmosphere promotes vapor phase emissions o Large surface areas and shallow depths promote increased volatilization o Mechanical treatment methods (such as aeration) increase volatilization
Open Roofed Tanks	o Wastes directly exposed to atmosphere (promotes vapor phase emissions) o Mechanical treatment or frequent mixing will increase volatilization
Landfills	o Volatilization of vapor phase constituents through the sub-surface and daily/permanent cover o Poor or no daily cover increases volatilization o Open trench fill operations allow direct exposure of waste to atmosphere o Volatile gases transported by convection of biogenic gases released via routine landfill venting (particularly important in sanitary/hazardous mixed fills) o Particulate releases generated by machinery during filling operations o Particulate releases due to wind erosion of cover and/or exposed wastes
Land Treatment Units	o Wastes normally in direct contact with atmosphere o Application techniques which maximize waste contact with atmosphere, such as surface spreading or spray irrigation promote increased volatilization o Particulate releases due to wind erosion

EXHIBIT 7-1 (Continued)

UNIT POTENTIAL FOR AIR RELEASES AND MECHANISMS OF RELEASE

Unit type	Characteristics and Mechanisms of Release
Waste Piles	o Particulate emissions from uncovered waste piles o Location of waste pile in open area with no erosion protection promotes particulate generation o Waste handling activities on and around pile increase emissions o Volatile emissions are likely to be rare, but can occur based on waste composition
Drum Storage Areas	o Vaporization from drums frequently left open to atmosphere or from poorly sealed drums o Vapor emissions from areas containing leaking drums
Covered Tanks	o Volatile releases from pressure venting, poorly sealed access ports, or improperly operated and maintained valves and seals.
Incinerators	o Stack emissions of particulates o Stack emissions of volatile constituents High temperatures may cause volatilization of low vapor pressure organics and metals o Volatile releases via malfunctioning valves during incinerator charging
Non-RCRA Wastewater Treatment Ponds and Tanks	o Low concentration wastes may volatilize due to large surface area and active waste treatment. Releases can be significant due to generally large treatment capacities
Other Design and Operating Practices	o Inadequate spill collection systems promote intermittent air releases o Lack of vapor collection systems for use during container/tank cleaning operations o Absence of dust suppression or particulate control measures

The following section discusses the waste and constituent-specific factors the investigator should consider in assessing a waste's potential to release airborne constituents.

B. Waste Characteristics

Only certain hazardous constituents have a significant potential for air releases. This section identifies these constituents and the factors that affect their release. The physical form of the waste contained in a solid waste management unit will determine to a great extent the potential for air releases from the unit. Wastes may be solid, dilute aqueous solutions, dilute organic solutions, or concentrated solutions.

Air releases from solid wastes, such as those placed in landfills or waste piles, will be governed by different principles than govern releases from liquid wastes. The two types of emissions of greatest concern are:

(1) volatiles; and

(2) particulates.

We discuss below the characteristics that affect the potential for each type of emission. These characteristics are summarized in Exhibit 7-2, which outlines the likely unit types and appropriate parameters to consider when evaluating airborne releases from different types of waste streams (e.g., whether the release will be volatile or particulate). The investigator may find it useful to consider these factors if he/she is uncertain about the potential for constituents to release, based solely on unit characteristics and the lists of constituents of concern for vapor-phase and particulate emissions provided in Exhibits 7-3 and 7-4. A potential use of this information on the factors that effect the potential for air releases would be to use it to help support the investigator in determining that certain units will not have air releases.

1. Volatile Emissions

Volatile constituents of concern for air releases include organic vapors and volatile metals (e.g., arsenic and mercury). Exhibit 7-3 lists a select number of hazardous chemical compounds which EPA's Office of Air Quality Planning and Standards (OAQPS) considers to be of prime concern with respect to vapor phase air releases. The table also lists the RCRA waste codes for waste streams that contain these constituents to aid in their identification. While these wastes are of primary concern, many other wastes have the potential to volatilize. Therefore, where there is a large quantity of waste, the investigator should address both total volatile organic compounds (VOC) emissions as well as emissions of the specific compounds listed in Exhibit 7-3.

The concentration of specific constituents in each unit is another factor governing the potential for air releases. The

EXHIBIT 7-2

PARAMETERS AND MEASURES FOR USE IN EVALUATING POTENTIAL AIR RELEASES OF HAZARDOUS WASTE CONSTITUENTS

Emission and Waste Type	Units or Concern[1]	Useful Parameters and Measures
A. Vapor Phase Emissions		
-- Dilute Aqueous Solution[2]	Surface Imp., Tanks, Containers	Solubility, Vapor Pressure, Partial Pressure,[3] Henry's Law
-- Conc. Aqueous Solution[2]	Tanks, Containers, Surface Imp.	Solubility, Vapor Pressure, Partial Pressure, Raoults Law
-- Immiscible Liquid	Containers, Tanks	Vapor Pressure, Partial Pressure
-- Solid	Landfills, Waste Piles, Land Trt.	Vapor Pressure, Partial Pressure, Octanol/Water Partition Coeff.
B. Particulate Emissions		
-- Solid	Landfills, Waste Piles, Land Trt.	Particle Size Distribution, Site Activities, Management Methods

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[1] Incinerators are not specifically listed on this table because of the unique issues concerning air emissions from these units. Incinerators can burn all the forms of waste listed in this table. The potential for release from these units is primarily a function of incinerator operating conditions and emission controls, rather than waste characteristics.

[2] Although the octanol/water partition coefficient of a constituent is usually not an important characteristic in these waste streams, there are conditions where it can be critical. Specifically, in waste containing high concentrations of organic particulates, constituents with high octanol/water partition coefficients will adsorb to the particulates. They will become part of the sludge or sediment matrix, rather than volatilizing from the unit.

[3] Applicable to mixtures of volatile components.

EXHIBIT 7-3

HAZARDOUS CONSTITUENTS OF CONCERN AS VAPOR RELEASES

Hazardous Constituent	RCRA Waste Codes
Acetaldehyde	K001,U001
Acrolein	K012
Acrylonitrile	K011,K012,K013,U009
Allylchloride	F024,F025
Benzene	F024,F025,K001,K014,K019,K083,K085,K103,K105
Benzyl chloride	K015,K085,P028
Carbon Tetrachloride	F001,F024,F025,K016,K016,K020,K021,K073,U211
Chlorobenzene	F001,F002,F024,F025,K015,K016,K085,K105
Chloroform	F002,F024,F025,K009,K010,K016,K019,K020,K073, K021,K029,U044
Chloroprene	F024,F025
Creosols	F004,U052
Cumene (isopropylbenzene)	U055
1,4-dichlorobenzene	F002,F024,F025,K016,K085,K105,U072
1,2-dichloroethane	K018,K019,K020,K029,K030,K096,F024,F025,U077
Dichloromethane	F001,F002,F024,F025,K009,K010,K021,U080
Dioxin	F020,F021,F022,F023,F028
Epichlorohydrin	K017,K019,K020,U041
Ethylbenzene	F003
Ethylene oxide	U115
Formaldehyde	K009,K010,K038,K040,U122
Hexachlorobutadiene	F024,F025,K040,K016,K018,K030,U128
Hexachlorocyclopentadiene	F024,F025,K032,K033,K034,U130
Hydrogen cyanide	F007,F009,F010,K013,K060

EXHIBIT 7-3 (cont.)

HAZARDOUS CONSTITUENTS OF CONCERN AS VAPOR RELEASES

Hazardous Constituent	RCRA Waste Codes
Hydrogen flouride	
Hydrogen sulfide	
Maleic anhydride	K023,K093,U147
Methyl acetate	
N-Dimethylnitrosamine	U100
Naphthalene	F024,F025,K001,K035,K060,K087,U165
Nitrobenzene	F004,K025,K083,K103,U169
Nitrosomorpholine	
Phenol	K001,K022,K087,U188
Phosgene	P095
Phthalic anhydride	K016,K023,K024,K093,K094,U190
Polychlorinated biphenyls	K085
Aroclor 1242	
Aroclor 1248	
Aroclor 1254	
Aroclor 1260	
Propylene oxide	
1,1,2,2-tetrachloroethane	F024,F025,K016,K019,K020,K021,K030,K095,K096,U209
Tetrachloroethylene	F001,F002,F024,F025,K016,K018,K109,K020,K021,U210
Toluene	F005,F024,F025,K015,K036,K037,U220
1,1,1-trichloroethane	F001,F002,F024,F025,K019,K020,K028,K029,K073.K095, K096,U226
Trichloroethylene	F001,F002,F024,F025,K016,K018,K019,K020,U228
Vinylchloride	K019,K020,K023,K029,K028,F024,F025,U043
Vinylidenechloride	F003,F025,K019,K020,F024,K029,U078
Xylenes	F020,U239

EXHIBIT 7-4

HAZARDOUS CONSTITUENTS OF CONCERN AS PARTICULATE RELEASES

Hazardous Constituent	RCRA Waste Codes
Arsenic	D000,D004,K060,K021,K084,P010,P011,P012
Asbestos	U013
Beryllium	D000,D006,P015
Cadmium	D000,D006,F006,F007,F008,F009,F061,F062, F064,F065,F067,F068,F069
Chromium	D000,D007,F006,F007,F008,F009,F002,F064,F069,F086,
Lead	D000,D008,F006,F009,K003,K044,K048,K052,K061,K062,K064,K069 K086,P110
Mercury	D008,K071,K106
Nickel	F006,F007,F008,F009

higher the concentration of a particular constituent present in a unit, the greater is its potential for air release. However, the intrinsic potential for a constituent to volatilize depends on chemical and physical properties that vary greatly between different constituents. Accordingly, a highly concentrated solution of one constituent may result in a lower release potential than a dilute concentration of another constituent.

Constituent-specific physical and chemical parameters are very important indicators of the potential for a vapor-phase release. The parameters most important when assessing the volatilization of a constituent include the following:

- Water solubility. The solubility in water indicates the maximum concentration at which a constituent can dissolve in water at a given temperature. This value can help the investigator estimate the distribution of a constituent between the dissolved aqueous phase in the unit and the undissolved solid or immiscible liquid phase. Considered in combination with the constituent's vapor pressure, it can provide a relative assessment of the potential magnitude of volatilization of a constituent from an aqueous environment.

- Vapor pressure. Vapor pressure measures the pressure of vapor in equilibrium with a pure liquid. It is best used in a relative sense; constituents with high vapor pressures are more likely to have releases than those with low vapor pressures, depending on other factors such as relative solubility and concentrations (i.e. at high concentrations releases can occur even though a constituent's vapor pressure is relatively low).

- Octanol/water partition coefficient. The octanol/water partition coefficient indicates the tendency of an organic constituent to sorb to organic constituents in the soil or waste matrices of a unit. Vapors with high octanol/water partition coefficients will adsorb readily to organic carbon, rather than volatilizing to the atmosphere. This is particularly important in landfills and land treatment units, where high organic carbon contents in soils or cover material can significantly reduce the release potential vapor phase constituents.

- Partial pressure. For constituents in a mixture, particularly in a solid matrix, the partial pressure of a constituent will be more significant than the pure vapor pressure. In general, the greater the partial pressure, the greater the potential for release. Partial pressures will be difficult to obtain. However, when waste characterization data is available partial pressures can be estimated using methods commonly found in engineering and environmental science handbooks.

- Henry's Law constant. Henry's law constant is the ratio of the vapor pressure of a constituent and its aqueous solubility (at equilibrium). It can be used to assess the relative ease with which the compound may be removed from the aqueous phase via vaporization. It is accurate only when used concerning low concentration wastes in aqueous solution. Thus it will be most useful when the unit being assessed is a surface impoundment or tank containing dilute wastewaters. Generally, when the value of Henry's Law constant is less than 10E-7 atm-m^3 the constituent will not volatilize from water. As the value increases the potential for significant vaporization increases, and when it is greater than 10E-3 rapid volatilization will occur.

- Raoult's Law - Raoult's Law can be used to predict releases from concentrated aqueous solutions (i.e. solutions over 10% solute). This will be most useful when the unit of concern entails container storage, tank storage, or treatment of concentrated waste streams.

For solid wastes, imiscible liquids, and wastes disposed of in landfills, land treatment, or waste piles, there are no simple measures that can be used to assess the potential for volatilization of a constituent. The investigator will need to consider the appropriate chemical, physical, and unit parameters, and then use his/her best judgment in determining the potential for release.

2. Particulate Emissions

Exhibit 7-4 lists hazardous constituents that are of special concern for particulate air releases. Particulate emissions from solid waste management units can contain organic material, heavy metals, or both. The heavy metals shown in Exhibit 7-4 are predominantly associated with particulate releases, although both arsenic and mercury may be present as vapor phase releases due to their relatively high vapor pressures. Similarly, the organic compounds shown in Exhibit 7-3 may also be found adsorbed or bound to soil and/or other particulate matter releases.

In general, there will be fewer facilities with particulate emissions. However, at some facilities particulate emissions may be very significant (e.g., discharges from a lead smelter) and threaten the safety of on-site workers and EPA personnel during a site visit.

The likelihood of particulate releases at hazardous waste management facilities is generally associated with landfills, land treatment units and/or waste piles. The potential for particulate releases is governed by different parameters than those that affect vapor-phase releases.

For particulate releases, the size distribution of the particles in the release plays an important role in both dispersion and actual exposure. Large particles will settle out of the air more rapidly than small particles, thus they will not travel as far off-site or be diluted as much by dispersion. Very small particles (i.e., those that are less than 5 microns in diameter), are considered to be respirable and thus present a greater health hazard than larger particles. The investigator should examine the source of the particulate emissions to obtain information on particle size.

The primary mechanism for generating particulate releases at hazardous waste facilities is wind erosion. In general, the unit's location will affect the potential for the wind to erode wastes in the unit. The unit's location and orientation with respect to the prevailing winds and large structures on-site will determine the unit's vulnerability to wind erosion and the potential for particulate releases. Agency personnel should determine the location of SWMUs of concern with respect to prevailing winds and the use of wind screens (both natural and man-made) and daily covers to determine the unit's vulnerability to wind erosion.

C. Pollutant Migration Pathway

The investigator should identify the migration route(s) for potential air releases in order to identify:

- The locations along the route where target populations may be exposed to the release; and
- Locations to sample for evidence of release (e.g., south or north edge of the unit), where no evidence of release exists, but the investigator believes, based on unit and waste characteristics, that releases may occur.

In identifying air pollutant migration pathways, the investigator should determine the direction of the prevailing winds around the facility, and characterize the geography (e.g., narrow valleys and urban areas containing large buildings, or artificial canyons) along the wind pathway. Using this information, he/she should be able to identify upwind and downwind sampling locations and target populations that may be exposed to air releases along their migration route.

The investigator may be able to obtain some of this information from local weather data bases as part of the PR. Most of this information, however, will probably be collected during the VSI.

D. Evidence of Release

The investigator should examine any available sources of information to identify evidence that constituents have been released to the air at a facility in a proportion that poses an actual or potential threat to human health and the environment. General considerations on how to look for evidence of release are discussed in Chapters Two and Three.

Direct evidence of air releases will include the following:

- o Air sampling/monitoring data associated with a particular unit (e.g., samples taken from above a NPDES unit; monitoring data required under a Clean Air Act permit);
- o Visual evidence of particulate releases from a unit;

Indirect evidence of release includes the following:

- o Evidence of contamination around the facility that may have resulted from an air release (e.g., accumulated particulate emissions from a smoke stack or landfill/waste pile);
- o On-site air monitoring data gathered under the OSHA program;
- o Records of citizen complaints associated with the facility concerning odors, headaches, nausea, or observed particulate releases.

During the viusal site inspection, the investigator should identify any evidence that hazardous constituents have released or are continuing to release from SWMUs at the facility to the air. During the visual site inspection he/she should confirm the presence of units of concern and look for evidence of particulate emissions from units. Although the investigator may occasionally smell vapor-phase releases, in most cases, these releases will be difficult to identify without samples. Procedures for collecting additional sampling information are discussed in Section III.

E. Exposure Potential

The investigator should evaluate available information on the location, number, and characteristics of potential receptors that could be affected by air releases at the facility. Human receptors are of primary concern for air releases. Potential receptor information will be used primarily in helping the investigator determine the need for interim corrective measures at the facility in order to address instances of air contamination posing especially high risks of exposure.

Population density and distance from the source are the primary factors in determining the significance of a potential exposure. Distance should be measured from the unit(s) containing the waste rather than from the facility boundary, although total facility emissions from all SWMUs should also be kept in mind. Most importantly, the investigator should consider the density of the population residing near the site, as well as transients such as workers in factories, offices, restaurants, motels, or students.

The most significant exposure potential will occur in situations when there is a high population density very close to the site. However, because concentrations can be quite high, even low density populations in such close proximity to the site are of concern. Dispersion can significantly reduce concentrations as distance from a site increases. Thus, the significance of high population density at larger distances from the site is reduced.

The investigator needs to consider the relationship between distance, concentration, and population density in evaluating the significance of an exposure potential. An additional factor to consider is the population located along the line of the most predominant wind direction at a site. Because the RFA is primarily concerned with continuous releases, populations located along this line downwind of the site are more likely to receive significant exposures than populations located along other vectors.

If the investigator determines that units at a facility are releasing large volumes of unsaturated hydrocarbons, he/she may need to consider population density over a much larger area. These constituents contribute to the formation of photochemical smog and ozone, which, in combination with other regional pollutant releases, can cause significant exposures over a wide geographic area.

F. Determining the Need for Additional Sampling Information

If the investigator determines, based on his inspection of the unit, that there is a significant potential for the unit to be releasing substantial quantities of volatile constituents and in consideration of the proximity of receptors, he/she may choose to sample to determine conclusively whether an air release is occurring which merits further investigation. We discuss in this section:

(1) General information on factors to consider in determining the need for additional sampling information; and

(2) Factors to consider in selecting sampling parameters.

1. General Information on Determining the Need for Sampling

The investigator should use his/her best professional judgment in determining when a unit may be releasing hazardous constituents to the air. In some situations, a unit may exhibit a strong potential for air releases, based upon unit and waste characteristics, but the investigator wants to confirm this with additional data. This may be necessary in situations where the owner/operator has not cooperated with EPA, and he/she may contest an EPA request to conduct further investigations by denying the presence of air releases.

2. Selection of Sampling Parameters

In selecting sampling parameters, the investigator should consider those constituents he/she believes to be of concern at the facility. These constituents are discussed in detail earlier in this chapter. In general, the investigator will be able to confirm a release when one constituent has been shown to release, and therefore, the number of parameters considered should be as limited as possible.

In many cases, the investigator will be able to confirm or deny the presence of an air release by sampling for VOCs with an indicator device. However, these devices can miss episodic releases. These devices (e.g., OVA and HNU) measure the concentration of volatile organics in the air, and thus provide a screening level technique for identifying releases. These sampling methods are discussed further in Section III.

III. OBTAINING ADDITIONAL SAMPLING INFORMATION

This section presents technical information related specifically to air releases to be considered when collecting additional sampling information in the SV. The information presented here should be used to help the investigator meet one of the primary goals of the SV:

- To collect additional sampling information to fill data gaps identified in the PR and VSI, leading towards final release determinations.

For each sampling method discussed, this section describes: 1) the general kinds of situations in which it will be appropriate to employ a specific technique, 2) technical information on how to conduct the sampling, and 3) specific details to be considered when evaluating the sampling results. This section does not provide the actual SOPs on sampling techniques here, although it does reference the relevant manuals where possible.

The choice of appropriate sampling methods will have a large impact on the cost and usefulness of the SV. The investigator should be confident when developing and reviewing the sampling plan that the procedures chosen will meet the needs of the RFA, while not resulting in the collection of unnecessary data.

We describe several sampling techniques that will be appropriate for identifying air releases during the RFA:

(1) Indicator techniques (OVA and HNU);

(2) Draeger tubes; and

(3) Monitoring stations with Tenax tubes.

1. Indicator Techniques (OVA and HNU)

The most common air sampling technique will involve the use of portable air monitoring instruments which measure total organic constituents present in the air at the sampling point. The two most commonly used devices are the organic vapor analyzer (OVA), and the HNU photoionization detector. The OVA detects the presence of organic compounds in air with a flame ionization detector, while the HNU detects organic compounds with a photoionization detector. While these units provide somewhat different results, this discussion will be limited to the HNU; most of the discussion will be applicable to use of the OVA.

The HNU provides the investigator with a quick and simple method for determining the presence of organic compounds in the air, and for providing a general indication of their magnitude. When evaluating the likelihood of releases at wastewater treatment tanks, the investigator should hold the HNU as close as possible to the unit and wait for the meter to equilibrate. The instrument provides a reading of organic vapor concentration in terms of parts per million.

The investigator should be aware that both of these instruments are calibrated to measure accurately only one volatile constituent: the HNU is calibrated for benzene, while the OVA is calibrated for methane. Thus, when encountering other organic constituents, the meter may indicate either higher or lower concentrations of that constituent than are actually present. The investigator should consider that these instruments provide general indications on the presence of volatile organics, not quantitative evidence. However, an HNU indication of organic vapors at a site may be sufficient to compel further investigations at that unit.

2. Draeger Tubes

When the investigator seeks more detailed information on the presence of organic constituents in the air, Draeger tubes can be useful for measuring specific constituents. This sampling technique shares the advantage of the HNU and OVA in that Draeger tubes are a portable, field technique, which does not require laboratory analysis.

Draeger tubes contain a sorbent material encased in a small glass tube, through which an air sample is pulled with a hand-held pump. The sorbent material has been chemically-treated to turn a color when the specific constituent of concern is present in the air. The length of the stained material indicates the concentration of the constituent in the air; the tube contains a calibrated scale for reading concentration in parts per million directly off of the tube.

Draeger tubes have several advantages over the indicator techniques discussed above. Because they are constituent-specific, they provide a better indication of the toxicity posed by an air release. They also will provide a more accurate measurement of the constituents of concern, since there is no problem based upon the calibration to one constituent. However, Draeger tubes are not available for all volatile constituents of concern. They are also slightly more difficult to use, in that the investigator should carry around Draeger tubes for each of the potential constituents or vapor classes of concern at the site. Still, they should be considered extremely portable.

3. Monitoring Stations with Tenax Tubes

In some situations, the investigator may find it necessary to install a stationary monitoring station for making more quantitative determinations of air releases at a site. This air monitoring will involve the use of Tenax tubes to collect organic constituents, and subsequent laboratory analysis of these constituents with a GC/MS. This sampling technique will seldom be necessary during the RFA, primarily due to its technical difficulty, and because the simpler techniques described here will generally provide sufficiently useful results.

The investigator should consult with qualified professionals familiar with the use of air monitoring devices, when he/she believes that more quantitative evidence of a release will be necessary in the RFA.

IV. MAKING RELEASE DETERMINATIONS

The final task in the RFA process is to make determinations of release potential throughout the facility and to make recommendations for further action to address these potential releases. This section summarizes information that the investigator should consider when making release determinations in the air pathway.

Chapter Four presents the general procedure to be followed when making release determinations during the RFA. This involves:

- Evaluating sampling results from the SV;
- Integrating facility information gathered in the PR and the VSI;
- Determining the likelihood of release at the facility; and
- Making recommendations concerning the need for further investigations.

The investigator should rely upon his/her best professional judgment when making release determinations in the air pathway. In order to make a release determination, the investigator will probably have to demonstrate that a unit of concern contains constituents that have a potential for vapor-phase or particulate release. In most cases, this information on constituent release potential along with some indirect evidence of release (e.g., odors, observed particulate releases, facility-wide sampling data) will prove sufficient to make an adequate release determination. However, in certain cases, it will be necessary to obtain existing or new direct evidence of release that links constituents identified through sampling with constituents in the unit.

Exhibit 7-5 is a checklist that should help the investigator evaluate specific factors to identify air releases. In identifying releases, the investigator should consider types of information presented in Exhibit 1-1, which are highlighted in the checklist.

EXHIBIT 7-5

CHECKLIST FOR AIR RELEASES

- Unit Characteristics
  - Is the unit operating and does it expose wastes to the atmosphere?
  - Does the surface area of the unit create create a potential for air release?
- Does the unit contain waste that exhibits a potential for vapor phase release?
  - Does the unit contain hazardous constituents of concern as vapor releases?
- Does the unit contain waste and exhibit site conditions that suggest a potential for particulate release?
  - Does the unit contain hazardous constituents of concern as particulate releases?
  - Do constituents of concern as particulate releases (e.g., smaller, inhalable particulates) have potential for release via wind erosion, reentrainment by moving vehicles, or operational activities?
- Evidence of Air Release
  - Is there direct evidence of release from the unit (e.g., air sampling data; observed particulate releases)?
  - Is there indirect evidence of release from the unit (e.g., evidence of contamination around the facility that may have resulted from an air release; OSHA monitoring data; citizen compliants regarding health problems, odors, or observed particulate releases)?

CHAPTER EIGHT

SUBSURFACE GAS

I. INTRODUCTION

A. Purpose

This chapter provides technical information to support the investigation of releases of subsurface gas during the RFA. While Chapters Two, Three, and Four provide general guidance on conducting RFAs, this chapter focuses on specific factors unique to subsurface gas releases that should be considerd by the investigator.

B. Scope

In the RFA, investigators should determine whether releases of subsurface gas have occurred at a facility. In general, EPA's primary concern is to determine whether there are gas releases that could reach explosive levels in on-site or off-site buildings. Therefore, the primary constituent of concern in the subsurface gas investigation is methane, due to its explosive properties and frequency of detection in subsurface gas.

As with other media, the investigations that may be required in an RFI to determine the nature and extent of subsurface gas releases will be very resource intensive for both the owner/operator and for the Agency. Therefore, the investigator should also identify in the RFA those units/facilities that do not require further investigation for subsurface gas releases.

This chapter has been organized to reflect the separate phases of the RFA process:

- Making a preliminary assessment of subsurface gas releases in the PR;
- Obtaining evidence in a VSI;
- Collecting additional sampling information in a SV; and
- Making release determinations.

The first section describes the technical factors that should be considered during the PR and VSI. The second section describes the technical approach to obtaining additional sampling information in the SV for subsurface gas releases, and should be consulted along with Chapter Four on general guidance to be followed in conducting a SV. The final section discusses factors to consider when making release determinations of subsurface gas releases. This section also presents options for further investigation of subsurface gas releases to be evaluated at the end of the RFA.

II. CONDUCTING A PRELIMINARY REVIEW AND VISUAL SITE INSPECTION OF SUBSURFACE GAS RELEASE POTENTIAL

This section presents technical information related specifically to subsurface gas releases to be considered when conducting the PR and VSI. Accordingly, this section has been organized to reflect the primary goals of these steps in the RFA:

- Identifying and describing potential threats from subsurface gas at RCRA facilities; and
- Making a preliminary assessment of the need for and extent of sampling required.

This section presents technical information specific to this pathway covering the five types of information described in Exhibit 1-1, and technical information to help the investigator determine when additional sampling will be necessary in a SV to identify subsurface gas releases. The section discusses these six types of information separately:

(1) Unit characteristics;

(2) Waste characteristics;

(3) Pollutant migration pathways;

(4) Evidence of release;

(5) Potential receptors; and

(6) Determining the need for additional sampling information.

This information will be relevant to the evaluation of written documents in the PR and information gathered in a VSI.

A. Unit Characteristics

The design and operating characteristics of a unit will determine to a great extent its potential for releasing methane. The investigator should evaluate the unit characteristics of each SWMU or group of SWMUs at a facility to determine their potential for contributing to the generation and release of methane in subsurface gases.

The general potential for subsurface gas releases from a SWMU depends, to a great extent, upon the nature and function of the unit. The investigator should assess each unit based upon:

- An understanding of the overall potential of the unit to cause subsurface gas releases;

- An understanding of the primary mechanisms by which releases may occur from the unit; and

- An assessment of unit-specific factors which, singularly or in combination with each other, indicate the relative likelihood of subsurface gas releases from the unit.

The investigator should first consider the relative potential of the unit to release. Exhibit 8-1 presents a generalized ranking, in rough descending order, of the different types of SWMUs and their overall potential for causing subsurface gas releases, and a listing of the most common mechanisms by which these releases can occur from each unit type.

It should be understood that Exhibit 8-1 provides only a theoretical sense of the relative potential of these units to cause releases. Unit-specific factors should be evaluated in determining whether further investigations are needed for a particular unit.

Only two types of solid waste management units are of concern in the subsurface gas investigation due to their potential for generating methane or other subsurface gases of concern. These units include active and closed landfills and units that have been closed as landfills. Each is described more fully below:

- Landfills. Landfills are the most likely SWMUs to generate subsurface gases resulting in a release. The underground deposition of decomposable refuse with or without hazardous constituents provides a large source of gas and a driving force that can carry other gases venting to the atmosphere and/or migrating horizontally as a subsurface gas. Closing landfills with impermeable caps without venting systems retards the release of these landfill gases as surface emissions. In these instances, a large percentage of those gases migrate laterally through soils along confining barriers such as ground water tables, clay layers, synthetic liners, and compacted covers. This migration could cause significant accumulations of potentially explosive gas in facility structures or in buildings off-site.

- Units closed as landfills. Inactive SWMUs that have been closed as landfills may generate subsurface gases. These sites include closed surface impoundments or waste piles containing decomposable or volatile wastes with in-place impermeable covers. Similar to landfills, gases generated in sites closed as landfills may migrate laterally, possibly causing significant accumulations. However, closed surface impoundments and waste piles generally contain small quantities of decomposable and volatile wastes and are at shallow depths. Thus, significant gas migration and subsequent subsurface gas releases are less likely for these units than for landfills.

EXHIBIT 8-1

UNIT POTENTIAL FOR SUBSURFACE GAS RELEASES AND MECHANISMS OF RELEASE

Unit Type	
Closed Landfills	o Lateral migration of methane beneath landfill cap to on-site or off-site structures. o Migration of methane through conduits to on-site or off-site structures.
Active Landfills	o Lateral migration of methane beneath landfill cap to on-site or off-site structures
Closed Water Piles	o Lateral migration of methane beneath landfill cap to on-site or off-site structures.
Closed Surface Impoundments	o Lateral migration of methane beneath landfill cap to on-site or off-site structures.

Other SWMUs are unlikely to have subsurface gas releases because gases generated in the units are more likely to vent to the atmosphere than to concentrate in the unsaturated soil. Barriers (e.g., paving, compaction, or installation of covers for closure), can permit some lateral migration to occur from these units. Generally, however, this lateral migration will be limited to the extent of the barrier. Shallow SWMUs will also have a lower potential for releasing methane, since availability of oxygen will interfere with the anaerobic conditions supporting methane generation.

Although depth is one of several considerations for determining the potential for releases, the type of SWMU establishes potential migration pathways and the waste characteristics create the driving force for subsurface gas movement. Exhibits 8-2 and 8-3 illustrate some potential pathways from a few types of SWMUs. The investigator should consider the characteristics presented here when evaluating the likelihood of a SWMU to release methane.

B. Waste Characteristics

The investigator should attempt to identify the wastes originally contained within a SWMU or group of SWMUs during the PR, in order to determine their potential for generating methane. The investigation for methane is different than investigations for releases to the other media discussed in this guidance, in that the constituent of concern in this chapter is generated in the unit, rather than merely a waste present from a treatment, storage, or disposal activity. Therefore, the investigator should determine whether wastes conducive to the generation of methane are present in SWMUs at the facility.

Anaerobic decomposition of organic wastes generates large volumes of methane gas under the proper conditions. When methane is generated in SWMUs, the potential exists for it to accumulate under pressure and to migrate from the unit, thereby posing a significant risk of explosion. The methane may also be mixed with other volatile hazardous constituents present in the unit, and may increase the potential hazard associated with the accumulated gas.

Conventional solid waste refuse and biological sludges are the primary waste type of concern for generating methane gas. The volume of gas produced in the unit depends upon both the quantity and types of refuse present. Units may either contain primarily refuse or a mixture of refuse and hazardous wastes. Units where refuse has been codisposed with hazardous wastes may pose the most serious threat, because of the potential for other volatile hazardous wastes to be mixed with the methane.

Higher volumes of methane will be generated at units containing larger quantities of refuse. The volume of gas generated also depends upon the age of the unit and how long the waste has been in the unit. Methane generation will increase slowly after waste emplacement to a maximum generation rate which will slowly decline as the waste decomposes. The active lifetime for methane

EXHIBIT 8-2

SUBSURFACE GAS GENERATION/MIGRATION IN A LANDFILL

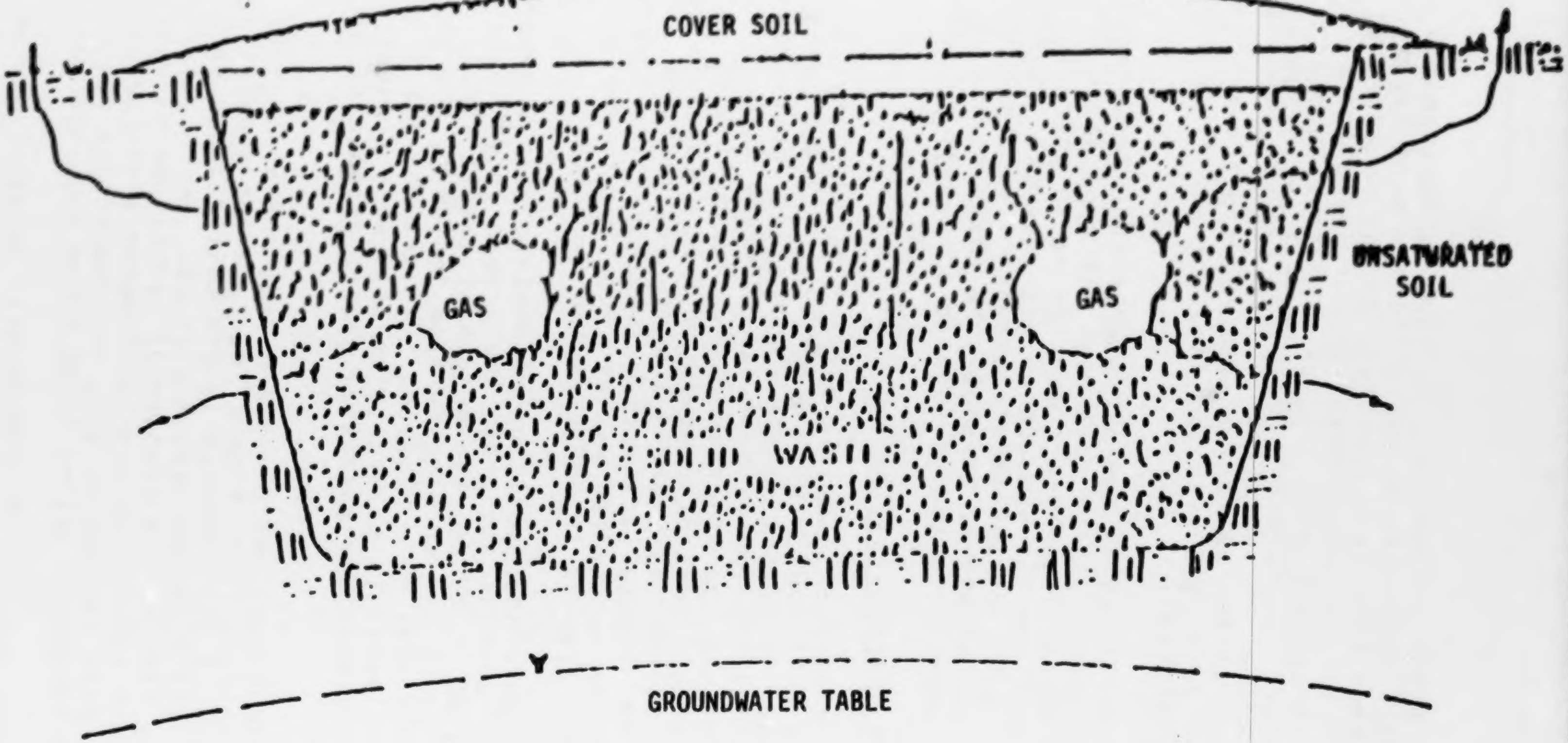
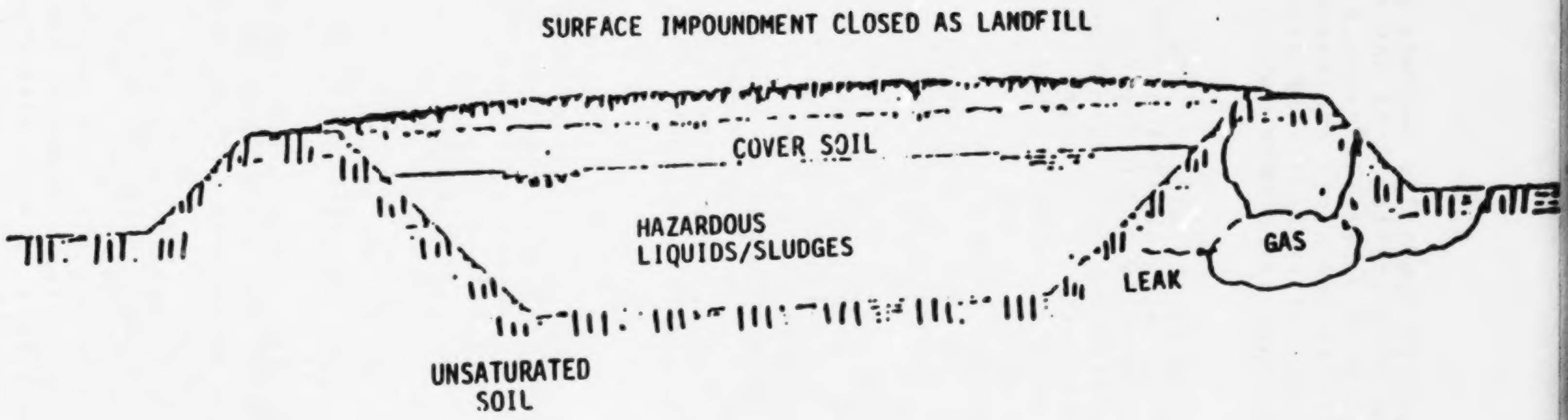

COVER SOIL
UNSATURATED SOIL
GAS
GAS
SOLID WASTES
GROUNDWATER TABLE

EXHIBIT 8-3

SUBSURFACE GAS GENERATION/MIGRATION FROM UNITS CLOSED AS LANDFILLS


SURFACE IMPOUNDMENT CLOSED AS LANDFILL
COVER SOIL
HAZARDOUS LIQUIDS/SLUDGES
GAS
LEAK
UNSATURATED SOIL

generation from units closed as landfills depends primarily upon the amount of precipitation infiltrating into the waste. Landfills in the arid Southwest will generally produce methane for 20-30 years, while landfills in the humid Southeast may only generate methane for 4-5 years after waste emplacement. Landfills with higher moisture content provide a more suitable environment for bacterial degradation.

The temperature of waste at the time of emplacement can also affect the methane generation rate. Wastes placed in landfills in the winter at temperatures below 10° C may not generate methane for up to 5 years, even in climates with warm summers, due to the insulating properties of the waste. The waste can remain at temperatures low enough to effectively inhibit bacterial decomposition for several years. The types of refuse disposed in the unit can also affect the rate of methane generation. Descriptions of the two types of refuse that can generate methane and a brief discussion of other wastes that may mix with methane follow:

- Rapid Decomposable Refuse. Rapid decomposable wastes will produce methane at high rates under the proper conditions. These wastes include organic sludges from wastewater treatment facilities, food wates, garden wastes, and other vegetable matter (e.g., grass clippings, tree trimmings, etc.). The high concentration of readily degradable organic compounds in these wastes provides an ideal energy source for the anaerobic organisms that produce methane.

- Slow Decomposable Refuse. Slow decomposables will not produce the immediate high volumes of methane possible with the rapid decomposables. However, they will produce methane at lower rates in the unit over a longer period of time, and thus also pose a substantial threat. Slow decomposables include paper, cardboard, wood, leather, some textiles, and several other assorted organic materials. Slow decomposables are commonly a large percentage of municipal refuse, and should be present in large quantities if the SWMUs contain municipal refuse.

- Other Wastes of Concern. Volatile organic wastes disposed in the unit of concern for subsurface gas releases may volatilize into the pockets of methane gas produced by refuse decomposition and increase the hazard associated with the gas. This situation could occur where liquids such as solvents have been disposed of in landfills or waste piles in high concentrations. These compounds are not likely to migrate from the unit unless methane is present to act as a carrier. However, certain volatile compounds would be likely to form mixtures with methane where wastes are codisposed. The volatile wastes and waste constituents of concern for subsurface gases are the same as those that have the potential for air releases. These are listed in Exhibit 7-2.

C. Pollutant Migration Pathways

The investigator should evaluate any available information pertaining to the hydrogeologic characteristics of a facility in order to determine the pollutant migration pathways associated with subsurface gas releases during the PR. As stated previously, methane can accumulate under pressure within certain types of units, and then migrate from that unit through the subsurface due to the force of this pressure.

Certain natural conditions and engineered structures can act as barriers that impede the migration or conduits that promote the migration of subsurface gas. For example, venting systems can prevent subsurface gas migration, while underground utility lines can promote migration. We describe below several factors that can affect the migration of subsurface gas:

(1) Natural barriers and conduits; and

(2) Engineered barriers and conduits.

1. Natural Barriers and Conduits

Gas migration can be impeded by various geologic barriers. A soil's effective porosity and permeability are perhaps the most important natural barriers to gas migration. Porosity is a function of soil type, moisture content, and weathering. Permeability is determined by soil type. Tight, uniform soild such as clays, at least to the depth of the unit, are good barriers. Sandy soil will likely encourage venting of gas to the atmosphere, thus preventing horizontal migration. Climatic conditions such as precipitation or freezing can also affect gas migration. Both factors tend to reduce the porosity of surface soils preventing upward gas migration.

Gas migration can also be impeded or prevented by hydrologic barriers such as surface water, ground water, and saturated soils. Subsurface gas does not penetrate ground water and surface water. Thus, if there is a lake or perennial stream between the unit and any structure, migration is unlikely. A high ground water table will restrict migration to the shallow unsaturated zone. High water tables also allow for the use of trenches as gas control devices.

Subsurface gases that come in contact with these barriers will tend to migrate towards the pathway of least resistance, either man-made or natural conduits. For example, sand and gravel lenses below a less permeable soil layer are excellent conduits for subsurface gas migration. As an uncommon example, if a landfill or site closed as a landfill was surrounded (along all sidewalls and bottom) by water, gas migration beyond the confining barrier would not be expected. In most cases, however, ground water and saturated soils only partially surround a unit (usually along the bottom). Thus, lateral or vertical migration can occur through this natural conduit.

2. Engineered Barriers and Conduits

Some facilities may have engineered structures which either intentionally or unintentionally impede the migration of subsurface gas. Engineered barriers include:

- Synthetic liners that effectively contain wastes;
- Slurry walls that border landfill units; and
- Gas control or venting systems.

The investigator should review documents on the design and operation of these systems and inspect the systems to confirm that they are functioning properly. Subsurface gas control systems are almost exclusively associated with disposal sites for municipal-type waste rather than for hazardous waste. These systems are probably only present at hazardous waste facilities where municipal waste is codisposed with hazardous waste or where a sanitary landfill is operating at the same site.

Gas migration from SWMUs may be facilitated by man-made structures located within the facility or near the property boundary. Examples of engineered structures which may act as conduits include:

- Underground power transmission lines;
- Sewer and drainage pipes; and
- Underground telephone cables.

Gases migrating from a SWMU may enter the gravel-backfilled trenches surrounding these structures and travel great distances to buildings or other engineered structures, resulting in a potential hazard. It may be useful to inspect the facility blueprints and check with utilities to the extent that these tasks were not completed during the PR or VSI in order to ensure that no structures are present that could increase the likelihood of gas migration to on- and off-site receptors.

D. Evidence of Release

The investigator should examine any available sources of information to identify evidence that subsurface gas has migrated from a facility. Most evidence of subsurface gas releases will usually be limited to official reports of explosions at or near the facility. In some cases, there may be sampling information taken from vents placed near the units indicating the presence of methane in a unit. Under most circumstances, the investigator should assume that units containing methane will pose a threat for migration and potential explosion.

E. Exposure Potential

The investigator should evaluate available information on the location, number, and characteristics, of buildings that could be affected by subsurface gas releases at the facility. As stated at the beginning of this chapter, the RFA will focus primarily on the potential for methane to migrate to on-site and off-site buildings. Typically, methane can migrate up to 1000 feet from its source, although it could travel further under ideal conditions.

Potential receptor information will be used primarily to help the investigator determine the need for immediate corrective measures at the facility in order to alleviate potentially high risks of explosion attributable to methane migration. In general, immediate actions may be necessary when the investigator encounters buildings with explosimeter readings above 25% of the LEL (lower explosive limit). The investigator should identify those structures that may be located close enough to a source of methane to warrant further investigation, and in some cases, sampling.

F. Determining the Need for Additional Sampling in the SV

If the investigator determines, based on his inspection of the unit, that there is a significant potential for the unit to generate methane, and that the site geologic and hydrogeologic conditions may promote migration, he/she may choose to sample to determine conclusively whether methane has been released. We discuss in this section:

(1) General information on factors to consider in determining the need for additional sampling information;

(2) Factors to consider in selecting sampling parameters; and

(3) An example to illustrate this discussion.

1. General Information on Determining the Need for Sampling

The following list presents several situations in which the investigator may find it useful to obtain additional sampling information during a SV:

- To identify explosive levels of methane in structures; to identify the need for emergency action;
- To confirm adequate operation of a landfill gas venting system;
- To identify the presence of refuse in units with unknown waste composition; and
- To confirm the presence of toxic constituents mixed with subsurface gas.

The investigator should use best professional judgment in determining when a SWMU may be a source of subsurface gases. When he/she believes that a unit contained decomposable wastes, and believes that the site conditions could facilitate methane migration, it may be appropriate to sample for methane at appropriate locations. These are described in detail in Section III of this chapter.

2. Selection of Sampling Parameters

As stated previously, methane will be the primary constituent of concern for investigations of subsurface gas releases. Therefore, the investigator will usually sample for methane when identifying releases.

However, under certain unusual situations (e.g., units where large quantities of refuse were codisposed with hazardous wastes), it may be necessary to identify the presence of other potentially hazardous constituents in subsurface gas. In these cases, the potential constituents of concern will the same as those identified as potential constituents of concern for air releases. The investigator should refer to Chapter Seven of this document for guidance on identifying and sampling these constituents of concern.

3. Example

An illustration of a situation in which sampling would be called for follows: An electroplating facility previously disposed some of its electroplating sludges along with refuse generated at the facility in a medium-sized landfill (2 acres). The company closed the landfill five years before the RCRA investigator began conducting the RFA. They closed the landfill by installing a clay cap with a vegetative cover.

The investigator found records of the past use of the landfill during the PR, and recognized a potential methane generation problem. After requesting a facility diagram from the owner/operator, the investigator discovered a telephone line running from off the facility boundary, underneath and adjacent to the landfill, towards one of the facility structures. The investigator recognized the underground telephone line to be a potential conduit for any methane migrating from the closed landfill.

Because the telephone line entered a facility structure, the investigator would decide to take explosimeter readings within the structure of concern. However, because the absence of methane in the facility structure does not necessarily prove the absence of methane, the investigator also decides to take several soil gas measurements around the perimeter of the landfill, in order to identify the presence of methane at the unit boundary.

III. COLLECTING ADDITIONAL INFORMATION IN THE SV

This section presents technical information related specifically to subsurface gas releases to be considered when collecting additional sampling information in the SV. The information presented here should be used to help the investigator meet one of the primary goals of the SV:

- To collect additional sampling information to fill data gaps identified in the PA, leading towards final release determinations.

For each sampling method discussed, this section describes: 1) the general kinds of situations in which it will be appropriate to employ a specific technique, 2) technical information on how to conduct the sampling, and 3) specific details to be considered when evaluating the sampling results. This section does not provide the actual SOPs on the sampling techniques here. However, it references the relevant manuals.

The choice of appropriate sampling methods will have a large impact on the cost and usefulness of the SV. The investigator should be confident when developing and reviewing the sampling plan that the procedures chosen will meet the needs of the RFA, while not resulting in the collection of unnecessary data.

One example of a sampling technique that will be appropriate for identifying subsurface gas releases during the RFA is the combustible gas meter (explosimeter) measurement. Considerations on how to use this device and on evaluating its results follow below.

1. Combustible Gas Meter

Methane field monitoring can be performed with combustible gas meters in buildings, sewers, or in the soil. A combustible gas meter will provide a reliable determination of combustible gas concentrations. It will not indicate whether or not the combustible gas detected is actually methane gas, although, if the waste in the unit could generate methane, it is likely that the meter is detecting methane. Any significant gas reading (whether it is methane or not) is of concern.

Combustible gas meters usually indicate the percentage of the lower explosive limit (LEL) of the atmosphere being monitored. The LEL indicates the lowest concentration of methane in air which could result in combustion, or in severe cases, an explosion. EPA guidelines under CERCLA consider 25% of the LEL to be an action threshold; the investigator should evacuate immediately when readings higher than 25% of the LEL are obtained.

Reported experience indicates 0 to 100 percent of the lower explosive limit detection to be accurate with hotwire catalytic combustion principal instruments. However, many users prefer instruments with the capability of determining both the 0 to 100 percent LEL and the percent methane present when the concentration exceeds 100 percent LEL (i.e., 5 percent methane). Dual scale instruments are available for this application. Typically, the 0 to 100 percent gas scale uses a thermal conductivity sensor.

The carbon dioxide in landfill-generated gas is reported to interfere with the thermal conductivity sensor, so the investigator should not assume that readings above 100 percent LEL are accurate.

Some of the single scale 0 to 100 percent LEL instruments can also be fitted with air dilution tubes or valves to allow readings of the percent gas when the concentration is above the LEL. Instructions on the use and calibration of these instruments should be obtained from the manufacturer.

Monitoring in a facility structure (e.g., buildings, sewers, existing monitoring wells, gas vents) should normally be done after the building has been closed overnight or for a weekend, and when the soil surface has been wet or frozen for several days. Monitoring or sampling should be done in confined areas where gas may accumulate, such as basements, crawl spaces, near floor cracks, attics, around subsurface utility connections, and in untrapped drain lines.

Soil gas monitoring can be performed to identify the potential for methane releases at a unit. The investigator will normally drill shallow wells of a minimal diameter (2") and insert the monitoring device in the hole. There will be some time delay due to the slow movement of gas through the soils and into the well.

IV. MAKING SUBSURFACE GAS RELEASE DETERMINATIONS

The final task in the RFA is to make release determinations and recommendations concerning the need for further investigation (e.g., an RFI). While subsurface gas problems may not occur at a large number of facilities, where they are encountered, they may pose extremely high risks to the investigator and facility employees.

Exhibit 8-4 is a checklist that should help the investigator evaluate specific factors to identify subsurface gas releases, or to identify sites that have a high potential for gas release and gas migration to on-site or off-site buildings. In identifying releases, the investigator should consider the series of factors described in the chapter and highlighted in the checklist to determine the potential for release. The primary factors include: whether or not the unit contains waste that generates methane, and the potential for migration through the subsurface.

Exhibit 8-4

Checklist for Subsurface Gas Releases

1. Potential for Subsurface Gas Releases

   - o Does the unit contain waste that generates methane or generates volatile constituents that may be carried by methane (e.g., decomposable refuse/volatile organic wastes)?

   - o Is the unit an active or closed landfill or a unit closed as a landfill (e.g., surface impoundments and waste piles)?

2. Migration of Subsurface Gas to On-site or Off-site Buildings

   - o Are on-site or off-site buildings close to the unit?

   - o Do natural or engineered barriers prevent gas migration from the unit to on-site or off-site buildings (e.g., low soil permeability and porosity hydrogeologic barriers/liners, slurry walls, gas control systems)?

   - o Do natural site characteristics or man-made structures (e.g., underground power transmission lines, sewer pipes/ sand and gravel lenses) facilitate gas migration from the unit to buildings?

3. Evidence of Release

   - o Does sampling data indicate a release of concern?

CHAPTER NINE

SOILS

I. INTRODUCTION

A. Purpose

This chapter provides technical information to support the investigation of releases to soils during the RFA. While Chapters Two, Three, and Four provide general guidance on conducting RFAs, this chapter focuses on specific factors unique to the soil medium that should be considered by the investigator.

This chapter has been organized to reflect the separate phases of the RFA process:

- Conducting a preliminary review of information on soil releases;
- Conducting a visual inspection of the facility;
- Collecting additional sampling information in the SV; and
- Making release determinations.

The first section describes the technical factors that should be considered during the PR and VSI. The second section describes the technical approach to obtaining additional sampling information in the SV for soils, and should be consulted along with Chapter Four on conducting a SV. The final section discusses factors to consider when making final release determinations to soils at the end of the RFA.

It should be understood that it is not the objective of an RFA to identify all areas of contaminated soil at a facility, and to require further investigaiton for all contaminated soil areas. Investigators should focus on identifying soil contamination which, through direct contact of humans or other potential receptors, or by leaching or otherwise migrating to other media such as ground water or surface water, poses a threat to human health and the environment. Not all soil contamination poses such risks; investigators should only focus on areas of soil contamination which clearly have the potential for causing serious environmental problems.

B. Scope

During the RFA, the investigator should evaluate the likelihood that the facility has releases to soils which pose a threat to human health and the environment. While in most cases this will relate to contamination from specific units, there may be situations where other sources of soil contamination may be impacting human health and the environment.

II. CONDUCTING A PRELIMINARY REVIEW AND VISUAL SITE INSPECTION OF RELEASES TO SOILS

This section presents technical information related specifically to the soil medium to be considered when conducting the PR and VSI. Accordingly, this section has been organized to reflect the primary goals of these processes described in Chapters Two and Three:

- o Identifying and describing potential releases to soils at RCRA facilities; and
- o Making a preliminary assessment of the need for and extent of sampling required.

This section presents technical details on each of the five types of information described in Exhibit 1-1:

(1) Unit characteristics;

(2) Waste characteristics;

(3) Pollutant migration pathways;

(4) Evidence of release; and

(5) Exposure potential.

In addition, technical information is provided to help the investigator determine when additional sampling will be necessary in a SV to identify soil releases. Each area is discussed separately.

A. Unit Characteristics

A unit's design and operating characteristics of a SMWU will determine to a great extent its potential for releasing hazardous constituents to soils. Many treatment, storage, and disposal units are designed to prevent releases to the environment. The investigator should evaluate the characteristics of each SWMU or group of SWMUs at a facility to determine their potential for releasing hazardous constituents to soils.

As with other media, the likelihood that a SWMU has contaminated soils is largely dependent on the nature and function of the unit. Therefore, each SWMU or grouping of similar units should be evaluated for its potential to release constituents that may contaminate surrounding soils. The unit evaluation should be based upon:

- o An understanding of the inherent design characteristics and features that might cause the unit to have a release to surrounding soils;

EXHIBIT 9-1

RANKING OF UNIT POTENTIAL FOR SOIL RELEASE AND MECHANISMS OF RELEASE

Unit Type	Release Mechanism
Surface Impoundment	o Releases from overtopping o Seepage
Landfill	o Migration of run-off outside the unit's run-off collection and containment system o Migration of spills and other releases outside the containment area from loading and unloading operations o Seepage through dikes to surrounding soils
Waste Pile	o Migration of run-off outside the unit's run-off collection and containment system o Migration of spills and other releases outside the containment area from loading and unloading operations
Land Treatment Unit	o Migration of run-off outside the containment area
Container Storage Area	o Migration of run-off outside the containment area
Above-ground Tank	o Releases from overflow o Leaks through tank shell o Spills from coupling/uncoupling operations
In-ground Tank	o Releases from overflow o Spills from coupling/uncoupling operations
Incinerator	o Spills or other releases from waste handling/preparation activities o Spills due to mechanical failure
Class I and IV Injection Well	o Spills from waste handling operations at the well head

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* The two remaining solid waste management units; waste transfer stations, and waste recycling operations generally have mechanisms of release similar to tanks.

- An understanding of the primary mechanisms by which the releases may occur from the unit and the potential for this release.

When assessing the likelihood of releases to soils from a unit, the investigator should initially consider the relative potential of the unit for a release. For example, an above-ground tank located directly on soil has a greater potential for a release than does the same tank raised two feet above a cement pad with adequate curbing. Exhibit 9-1 presents a generalized ranking of the different types of SWMUs and their potential for having releases that contaminate surrounding soils. Exhibit 9-1 also lists the mechanism for release associated with each unit type.

The major unit-specific factors the investigator should evaluate are discussed below.

1. Unit design

The design factors of the unit, including its capacity and dimensions, can indicate the potential for a soil release. For example, an undersized above-ground tank will be more susceptible to overtopping than an adequately sized unit.

Features designed to reduce or eliminate release should also be considered. Some features are better able to eliminate releases than others. A triple-lined landfill with a leachate collection system will be less prone to subsurface releases than a single clay-lined surface impoundment.

2. Operational history

The investigator should evaluate the unit's operational history for information which indicates that a release may have occurred. Operational factors that may influence the potential for a release include:

- The length of service life of the unit. Older units will have a greater potential for a release, particularly due to failure of liners or control equipment than newer units.

- Operational status (Active, inactive, closed)

- Operational procedures such as proper maintenance, regular inspections and records. A well maintained unit has less likelihood of leaks, spills or equipment failure.

3. Physical Condition of Unit

During the VSI, investigator should examine the units for evidence of releases or characteristics that could cause releases. For example, when examining a surface impoundment, he/she should determine whether the earthen dikes are structurally sound and capable of preventing releases. Cracks, slumping, or seeps around the toe in the dike may show evidence that the unit's condition may cause releases to the surrounding soils.

B. Waste Characteristics

The investigator should attempt to identify the wastes originally contained within a SWMU or group of SWMUS during the PR. In the RFA, the investigator should try to connect information on waste types, unit characteristics, and evidence of soil contamination to demonstrate the likelihood that specific SWMUs or groups of SWMUs have released constituents to the soils. This section describes technical factors to consider when identifying waste characteristics relevant to soil releases. It also discusses physical/chemical properties that affect the release potential of wastes and their subsequent transport in soils.

Information on wastes is usually available in Part A permit applications, inspection reports, and facility operating records reviewed during the PR. The investigator should compile specific information on waste characteristics in order to assess not only the potential for a release to soils, but also to identify the chemical form that the hazardous constituent might take in the soil environment, and to determine if a contaminant found in a soil release can be expected to migrate to other media.

Constituents tend to migrate in different forms and at different rates in the soil medium, depending upon their properties. Some Appendix VIII constituents are insoluble in water and bind tightly to soil particles, thus minimizing their migration potential. Therefore, it is important to evaluate a waste's mobility in order to determine its potential for dispersion in soils and its tendency for transfer to other media. Releases of organics may behave very differently than metals in the soil environment.

Hazardous metals and inorganics (e.g., arsenic and cyanide) may be relatively mobile. Other inorganics and metals (e.g., lead) are less mobile depending upon the pH of the wastes, and the ligands available in soil for complex formation.

The mobility of organic constituents can be expressed quantitatively by the sorption equilibrium constant (Kd). The value of K_d depends upon the organic content of the soil and the constituent-specific soil adsorption coefficient (K_{oc}).

The investigator will seldom have access to information on organic content of soils at a facility; instead it will be more useful to estimate the relative mobility of a constituent as expressed by K_{oc}. K_{oc} values have been calculated for only a small set of hazardous constituents; however, the octanol-water coefficient as expressed by (Kow), can be used as an indicator of Kd. Appendix E presents Koc and log(Kow) values for most constituents of concern. Because these values are log values, chemicals with K_{ow} values of more than two can be considered relatively immobile. Values less than one are considered to be mobile.

The volatility and biodegradability of constituents can also be important in identifying whether contaminated soil can act as a transfer medium. For example, highly volatile components of a past release may no longer be present for detection in a sampling program. Readily biodegradable components also may not be present, although certain degradation products may indicate that a release has occurred.

C. Pollutant Migration Pathways

The investigator should evaluate during the PR available information pertaining to potential soil migration pathways at a facility. Contaminated soils can transfer chemicals to ground water by leaching, to surface water by contaminating run-off, and to air by the suspension of contaminated particulates. This information will play a major role in identifying the potential for intermedia transfer of releases during the PR.

The identification of migration pathways associated with soil releases will be most important when the soil is being evaluated as a transfer medium. Basic to any evaluation of pathways for soils is the assessment of site geology, soil type, and climate. This evaluation relies on standard information usually available during the PR for each site. The primary climatic effect that should be determined is the annual rainfall. Sites located in regions with high annual or seasonal precipitation will have a greater potential for releases to spread through the soil or to the other aqueous media. Conversely, very arid regions may be susceptible to wind-borne distribution of contaminated soil particulates.

The investigator should evaluate the site's topography and look for low lying areas where spills may collect. He/she should also estimate the proximity of the unit in question to surface water, particularly locations within flood plains.

The underlying geology of a site should be determined in order to evaluate the potential of soils to transfer contaminants to that medium. Soil characteristics that are to be evaluated are dependent upon underlying geology.

The determination of site-specific soil characteristics will be useful when determining the impact of a potential soil release. Soils are characterized by particle size, ranging from large sand particles, to silt, to the small clay colloids. Loams are soils where these particles are found in various percentages. Releases will be distributed through sandy soils more readily than through clays. Clays usually have an associated attraction for certain chemicals since they are weakly ionized.

The organic content of soils will also affect their ability to bind or biodegrade certain chemical releases. This information is available for most sites from USGS or State Soil Conservation Service soil maps. Interpretive data are usually available along with the map. General information will often be included on the depth of a soil layer.

D. Evidence of a Release

During the PR, the investigator should examine available sources of information to identify evidence that constituents have been released to soils at a facility. The investigator should evaluate both direct and indirect evidence of release during the PR. Chapter Two outlines general considerations on looking for evidence of releases.

The VSI is particularly useful for identifying releases to soils. Stressed vegetation can indicate the likelihood of a soil release. Direct evidence of soil releases includes:

- Evidence of oiliness or slick on soils; and

- Discoloration from background soil color.

Direct evidence of a release may also include official reports of prior release incidents, such as a major tank leak onto the ground. Indirect evidence of a release to soils may be provided by ground-water monitoring data that show contamination. When the investigator identifies indirect evidence of this type, it may be possible to determine the source of the release by evaluating the pollutant/soil migration pathways and the waste characteristics at the facility. Soil sampling data may exist at some facilities, although this will not be likely, since there are no requirements for soil monitoring.

There are likely to be instances of soil contamination that cannot be linked directly to units at a facility. Areas that were used to handle wastes in the past but are now unused may have contaminated soil.

E. Exposure Potential

The investigator should evaluate available information on the location, number, and characteristics of potential receptors that could be affected by releases to soils at the facility. These receptors include human populations, animal populations (particularly any endangered or protected species), and sensitive environments.

While it is not within the scope of the RFA to estimate the risk associated with a release to soils, it is important to identify any potential for direct exposure to the release. Information on the potential for direct exposure include:

- The security of the facility. Is access to the site prevented by adequate fencing or barriers?

- The proximity of the unit/facility to children, specifically to schools and play grounds.

If the migration of chemicals from soil releases to other media has been identified, the sections in this Guidance on releases to those media should be refered to in order to determine exposure potential to constituents released and transfered to other media.

The investigator should evaluate the severity of the release to soils along with the potential for direct exposure. If receptors are currently being exposed to highly contaminated soils or have a high potential for being exposed, the investigator should consider recommending immediate corrective measures to limit access and direct exposure.

F. Determining the Need for Additional Sampling

The investigator may not be able to determine whether a release to soils from the unit has occurred, since existing data may be unavailable or insufficient. In cases where historical information and visual observations are not adequate to determine if a release from a unit to soil has occurred or is likely to have occurred, he/she should consider whether additional sampling and analysis would help make a determination. In this section, we present:

(1) General information on factors to consider in determining the need for additional sampling information;

(2) Factors to consider in selecting sampling parameters;

(3) An example to illustrate this discussion.

1. General Information on Determining the Need for Sampling

Soil sampling during the SV will generally be confined to surface soils or to shallow coring using hand equipment. Because of the relative ease in obtaining soil samples, in some cases, soil sampling may be used to obtain information on releases to ground water where existing wells may not be adequate and new well placement is beyond the scope of the RFA.

The following are situations where soil sampling data could be useful:

- Visual examination reveals an area at a facility where unspecified wastes were applied in liquid form for several years. Facility is situated on sandy soils with rapidly moving ground water, with nearby drinking water wells located apparently downgradient. Sampling data would reveal presence of and types of constituents in the soil, which if positive could trigger additional ground water investigations.

- Ground-water data downgradient from an above-ground tank indicates contamination from its wastes. No record of a spill exists and the unit appears structurally sound, however, the observed contamination should have migrated to the ground-water through the soils.

- Drainage patterns show that runoff from a landfill tends to collect in a low lying area. Constituents expected to be released sorb to soils and contamination of the run-off can be verified.

2. Selection of Sampling Parameters

Knowledge of the wastes that may be potentially released from a unit is the starting point when identifying sampling parameters. However, many SWMUs have incomplete or no data on the wastes deposited over time. When little is known of the wastes managed in the unit, GC/MS scans for volatiles, acid extractables or base/neutrals become a good starting point when selecting parameters for analysis in soils.

Metals are also of concern under RCRA. If a waste source is hazardous due to EP Toxicity, the metals of concern are a smaller subset: arsenic, barium, cadmium, lead, mercury, selenium, and silver. The following metals precipitate readily under many naturally occurring conditions and may be detected in soil analysis: cadmium, lead, nickel and zinc.

The volatile GC/MS scan identifies chemicals that are characteristic of solvents and lighter petroleum products. Because they are volatile, they can evaporate from soil releases into the air. Evidence of these chemicals may be difficult to obtain in older releases.

The acid extractables (i.e., phenols) may be present in heavier petroleum feed stocks and certain industrial processes (e.g. pentachlorophenol from wood preserving). Phenol and the mono-halogenated phenols biodegrade in a soil environment. Pentachlorophenol is very persistent.

Base/neutral compounds can often be found in wastes from industries such as the plastics and synthetic fibers manufacturers. The pesticide scan identifies pesticides that are found in pesticide wastes and products from the agrichemical industry.

All monitoring data should be coordinated with the unit specific information available on the potential for constituents to be released to soils and the investigator's professional judgment.

III. COLLECTING ADDITIONAL SAMPLING INFORMATION IN THE SV

This section presents technical information related specifically to the soils medium to be considered when collecting additional sampling information in the SV. Accordingly, the information presented here should be used to help the investigator meet one of the primary goals of the SV:

- To collect additional sampling information to fill data gaps identified in the PR and VSI.

For each sampling method discussed, this section describes: 1) general situations where it is appropriate to employ a specific technique, 2) technical information on how to conduct the sampling, and 3) specific details to be considered when evaluating the sampling results. This section does not provide the actual SOPs on the sampling techniques. However, it references relevant manuals.

The choice of appropriate sampling methods will have a large impact on the cost and usefulness of the SV. The investigator should be confident when developing and reviewing the sampling plan that the procedures chosen will meet the objectives of the RFA, while not resulting in the collection of unnecessary data. We discuss soil sampling at surface, shallow depths, and special cases where deep samples are warranted.

A. General Information on Selecting Sampling Locations

The investigator should use best professional judgment in determining appropriate locations for soil sampling. During the visual site inspection, pertinent topographic features should be located. These features include drainage patterns, fill areas, erosional and depositionals areas. Any surface run off, seeps, springs and the proximity to surface water and wet areas should also be noted. Releases from a unit will seek the lowest area. Such low spots may be depositional areas for any released chemicals and would be the best location to start any subsequent sampling. Topographic maps are helpful. Strategically locating the sampling areas should minimize the number of samples necessary and the effort for their collection.

After identifying the areas designated for soil sampling, the exact location of the sample area and the specific sample location should be recorded on a site map. Soil sampling will be generally completed by using surface samples and hand equipment. Surface soil sampling should be conducted in depositional areas since these areas tend to have higher concentrations of released constituents. This is valuable for the screening function of the RFA, but these levels are not indicative of the overall area conditions. The extent of a release will be determined under the RFI.

The depth of the sample (e.g., surface, one foot below surface) should be recorded in a field log book. When identifying metal constituents from a release, it may be important to consider soil type since many have natural background levels of certain heavy metals.

B. Sampling Methodology and Evaluation of Results

Soil sampling will usually be done using hand equipment such as stainless steel spoons, scoops, shovels, hand auger and small diameter push tubes. This equipment is available for sampling at shallow depths; however, when soil is difficult to penetrate, even shallow sampling may require power equipment such as augers. Shelby sampling tubes or thin wall push tubes can be used by both hand and power equipment. Stainless steel components are recommended for these tubes. Soil samples are extruded from the tubes for logging and for selective sampling. The tubes can also be capped and sent directly to the laboratory for analysis.

Surface sampling of soils can be done with a stainless steel spoon or scoop. Grass, leaves and other debris should be scraped off the surface prior to sampling. Shallow samples can be collected by digging a hole with a shovel or post hole digger, then removing all loose soil from the hole and sampling with a stainless steel spoon at the desired depth. For densely packed soils or deeper soil samples, a soil auger may be used. The sample is extruded and 100 to 200 grams of the sample is transfered to a 250 ml container. A label is attached with required information and the depth of the sample, and its location is recorded in the field logbook.

Soil samples are collected in wide-mouth glass jars equipped with Teflon-lined screw caps. These samples require no preservation or refrigeration. Tape the lid securely and mark with collector's initials. Carefully pack the samples with the appropriate chain-of-custody forms. Chapters six and seven of the "Revised Draft Protocol for Ground-Water Inspections at Hazardous Waste Treatment, Storage and Disposal Facilities" October 1985, are a good reference for these soil sampling techniques. Characterization of Hazardous Waste Sites - A Methods Manual, Volume II. Available Sampling Methods is also a good reference for more detail on soil sampling techniques.

If it is necessary to sample soils at depths greater than 18 inches, sampling with power equipment can be done. It may be important to sample at lower depths when the release is very mobile and not of recent occurrence. The investigator may suspect that the release has moved several feet below the surface and that surface sampling may no longer show evidence of the release. Split barrels or piston-type samplers will be most useful in these situations. These methods are based on ASTM D1586-67(1974), "Method for Penetration Test and Split Barrel Sampling of Soils", and ASTM D1587-74, Thin Walled Tube Sampling of Soils.

The sampling of soils at depths greater than 4 feet can be accomplished by the use of test pits and trenches. The size of the pits and trenches will vary, but should be large enough to permit the entry of personnel, under strict safety requirements. The excavation of the pits is performed most commonly by a backhoe. Because of the equipment involved, sampling from a pit will seldom be appropriate in the RFA, although this method may be applied in certain circumstances when it is valuable to make a visual in situ inspection. This technique may be applied in situations where the investigator suspects that the release may be in pockets distributed both horizontally and vertically throughout the soils, and may not be detected readily by sample borings.

Once the pit or trench has been opened, it should be stabilized by sloping the walls or by the use of shoring material. Sampling then occurs at designated spots by using scoops, shovels or hand augers. All pertinent information on pit location and sample location within the pit should be recorded in the field logbook. Photographs are a valuable aid when identifying the exact location of a sample within a pit or other subsurface visual evidence of contamination.

The exact depth and construction of a test pit should be designed by a field geologist or soils scientist. Sufficient space on site should be maintained for placement of removed material. After sampling, backfill material should be returned to the pit under the direction of the field geologist or soils scientist.

IV. MAKING A RELEASE DETERMINATION

The final task in the RFA is to make determinations of release potential throughout the facility and to make recommendations for further action to address potential releases. This section summarizes information that the investigator should consider when making release determinations for the soils media.

Chapter Four presents the general procedure to be followed when making release determinations at the end fo the RFA. This involves:

- Evaluating sampling results from the SV;
- Integrating facility information gathered in the PR, VSI, and SV to determine the likelihood of release at the facility; and
- Making final recommendations concerning the need for further investigations.

The investigator should rely upon his/her best professional judgment and available information when making determinations as to whether or not contaminated soils pose a potential or actual threat to human health and the environment. Further investigations should be required if it is determined that exposure of receptors is occurring or is likely to occur through direct contact with contaminated soils, or if there is a likelihood that contaminated soils are causing contamination of ground water or other human health or environmental problems.

Exhibit 9-2 is a checklist that should help the investigator evaluate specific factors to identify releases to soils and to determine the effect on human health and the environment. When identifying releases, the investigator should consider the series of characteristics described in the chapter and highlighted in the check list that determine the potential for releases to soil from units of concern. These characteristics include: the unit type (e.g., above ground tank), the unit's containment systems (e.g., liners), and the unit's design capacity. Also, factors such as the unit's age, condition, the quality of its operating procedures, and whether or not the unit has a record of compliance problems may indicate the potential for a release.

EXHIBIT 9-2

CHECKLIST FOR RELEASES TO SOILS

Identifying Releases

Potential for Soil Releases from the Unit

- Unit type and design
  - Does the unit type (e.g., landbased) indicate the potential for release?
  - Does the unit have engineered structures (e.g., liners, proper construction material) designed to prevent releases?
- Unit operation
  - Does the unit's age (e.g., old unit) or operating status (e.g., inactive) indicate the potential for release?
  - Does the unit have poor operating procedures that increase the potential for a release?
- Physical condition
  - Does the unit's physical condition indicate the potential for release (e.g., lack of structural integrity)?
- Site characteristics that affect the ability for soil to act as a transfer media
  - Is the soil particle size large (e.g., sand) such that the migration of releases through the soil can readily occur?
  - Is the soil high in organic material that may either bind or biodegrade certain chemical releases?
  - Is the soil layer shallow (e.g., less than six feet)?
  - Is high annual rainfall characteristic of this climate?
  - Is the unit located near a body of water (e.g., in flood plain)?
  - Is runon and runoff from the unit controlled?

APPENDIX A

SAMPLE RFA REPORT OUTLINE

APPENDIX A
SAMPLE RFA REPORT OUTLINE

I. Conducting the Preliminary Review

- A. Facility Waste Generation and Manufacturing Process Description
- B. General Background on Environmental Setting
- C. Locations and Characteristics of SWMUs and Other Potential Areas of Concern
  - 1. Facility Map Identifying SWMUs and Potential Areas of Concern
  - 2. SWMU Information (for each SWMU or location of concern)
    - a. Unit Characteristics
    - b. Waste Characteristics
    - c. Pollutant Migration Pathways
    - d. Evidence of Release
    - e. Exposure Potential
- D. Identifying Data Gaps and the Need for Additional Owner/Operator Information

II. Conducting the Visual Site Inspection

- A. Description of VSI Activities and Observations
- B. Update SWMU Information Based Upon VSI Results
- C. Conclusions and Recommendations for Further Action at Each SWMU/Location
  - 1. No Further Action
  - 2. Conducting a Sampling Visit
  - 3. Conducting a RCRA Facility Investigation
  - 4. Implementing Interim Measures

III. Conducting the Sampling Visit

- A. General Description of Sampling Objectives
- B. Sampling Plan for SV
- C. Results of Sampling Visit
- D. Conclusions and Final RFA Recommendations for Further Action at Each SWMU/Location

APPENDICES

- A. Visual Site Inspection Logbook
- B. Photographic Documentation of VSI
- C Sampling Visit Logbook
- D. Photographic Documentation of SV
- E. Sampling Visit Safety Plan

APPENDIX B

INFORMATION SOURCES

RFA INFORMATION SOURCES

This appendix provides details on the many sources of information whcih may be useful during the RFA, particularly the preliminary review. Most of these sources will be readily available to Regional/State staff. This section provides a brief description of the contents of each source and information on how to obtain them.

I. RCRA Sources B-1

  1. Permit Applications B-1
  2. RSI #3 Submission (SWMU Response) B-1
  3. Compliance Inspection Reports/Information from Enforcement Orders B-2
  4. Exposure Information Report B-2
  5. Other RCRA Sources B-2

II. CERCLA Sources B-2

  1. CERCLA PA/SI Reports B-2
  2. HRS Documentation B-3
  3. CERCLA RI/FS Studies B-4
  4. CERCLA 103(C) Notifications B-4

III. Other Federal Environmental Program Sources B-4

  1. NPDES Permits and Permit Applications B-4
  2. Clean Air Act Permits and Permit Applications B-4
  3. TSCA/OSHA Inspections B-5
  4. Department of Defense Installation Restoration Program (IRP) Reports B-5

IV. Other Miscellaneous Sources B-5

  1. Aerial Photography B-5
  2. State/Local Well Permits B-6
  3. U.S. Geological Survey and State Hydrogeologic Maps B-6
  4. U.S. Soil Conservation Service Soil Maps B-7
  5. GEMS (Graphical Exposure Modeling System) B-7
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RFA INFORMATION SOURCES

I. RCRA Sources

1. Permit Applications

Part A notifications and Part B applications for permits contain a sizable amount of information on the facility design and physical characteristics of the surrounding area. This information will sometimes apply to both unregulated releases from regulated units and releases from unregulated ("old") units, and should prove invaluable at many facilities in assessing the potential for old units to contaminate ground water. If the facility is seeking only an above-ground storage facility permit, however, the permit application data may not provide much information useful in evaluating an "old" landfill.

Part B applications may not characterize the lower aquifers if they are not connected to the uppermost aquifer. If the application data are inadequate to properly assess the impacts to ground water, the information may need to be developed through other sources discussed later.

In addition to relevant data on the facility as a whole, the permit application also provides information that can be used to evaluate the potential for unregulated releases from regulated units, specifically surface water and air releases. Most of the pertinent data relate to the design and maintenance of the unit will be contained in the application. Part B permit applications for land disposal facilities will also provide information on whether actual releases have occurred.

It is important to evaluate well placement when reviewing ground water monitoring data for regulated units. In some cases the location of existing monitoring wells may make it difficult to determine if contamination results from the regulated unit, an unregulated unit, or both. Review of the analytical data must be coupled with data on well location and ground water flow to positively identify the source of the observed release.

The Regional offices and/or the State offices will have copies of the permit applications for the facilities within their jursidiction.

2. RSI #3 Submission (SWMU Response)

The data submitted in response to the Reauthorization Statutory Interpretation (RSI #3), dated February 5, 1985 from Jack W. McGraw, should provide information on the type and location of SWMUs, and information on the quantities and types of wastes disposed in the SWMUs. These submissions, however, may be incomplete or inaccurate, and should not be relied upon solely to identify and characterize SWMUs. In many cases, the owner/operator was unclear which units to consider SWMUs, and the historical information on wastes disposed in them may not have been readily available to the owner/operator.

The SWMU response will be available to Regional RCRA personnel.

3. Compliance Inspection Reports/Information from Enforcement Orders

Compliance Inspection Reports are available for most RCRA facilities. These reports contain useful information on site management practices, monitoring data, and unit conditions and should help in identifying problem units and releases for possible sampling. Comprehensive monitoring evaluations (CME's), which evaluate ground water monitoring systems at the facility, may provide an indication of whether prior releases have occurred at the facility. Frequent violations of operating standards may indicate prior releases. Some RCRA inspection reports will contain detailed information on the management practices at the facility, suggesting the wastes most likely to be found on site.

Enforcement actions at facilities may result in enforcement orders. Reports of these actions may provide useful information on releases at a site. In many cases, the investigator may be able to obtain information on unregulated units from results of investigations required in enforcement actions.

These reports will usually be kept on file in Regional and State offices with jurisdiction over the facility.

4. Exposure Information Report

The 1984 Hazardous and Solid Waste Amendments require owner/operators to submit an exposure information report (EIR) to describe the likelihood of exposure resulting from waste disposal activities. Only facilities seeking operating permits for landfills and surface impoundments are required to submit EIRs.

EIRs will be available at Regional/State offices for facilities within their jurisdiction.

5. Other RCRA Sources

Several additional RCRA sources may provide useful information during the RFA. These sources will all be on file at the Region/State office for facilities within their jurisdiction.

- Biennial report
- Operating log
- RCRA waste manifest
- Notice to local authority
- ACL requests

II. CERCLA Sources

1. CERCLA PA/SI Reports

Almost 15 percent of the facilities seeking RCRA Part B permits have received CERCLA inspections. The site inspection reports for these facilities can provide a considerable amount of information on facility and unit design and management, waste characterization, and pollutant dispersal pathways, particularly for SWMUs and inactive units. They may also have limited information about target populations. The exact amount of information provided in each report will depend on the amount of information available at the time the report was completed.

The CERCLA SI report is likely to provide some information for the following categories:

- o Facility design/management practices
  - -- Listing of SWMU operations, facility layout;
  - -- Discussion of conditions of identified SWMUs; and
  - -- Design specifications for SWMUs (when available).

- o Waste characteristics
  - -- Type and quantity of waste received to the extent known

- o Pollutant dispersal pathways
  - -- Analytical data on "observed releases" from the facility;
  - -- Geology, topography, hydrogeology, climate of the area (if unit could be releasing to ground water);
  - -- Climatic data (e.g. precipitation, wind data); and
  - -- Facility topography as it relates to surface drainage patterns.

- o Receptor characteristics
  - -- Size and characteristics of nearby populations and sensitive environments potentially exposed through air, surface water, and ground water routes.

In addition to reviewing the final SI report, the person conducting the RCRA preliminary assessment should also examine the CERCLA site file. These files contain supplementary information used to evaluate the site under CERCLA. These files include such items as:

- o Field log book for the SI
- o Trip reports for the SI
- o Records of communication
- o Miscellaneous historical data/reports

Except for the first item, the exact contents of the file will vary depending upon the type of information available and the data collection procedures used at the time of the CERCLA SI.

The CERCLA PA/SI reports will be on file in the Superfund division of Regional/State offices with jurisdiction over the facility.

2. HRS Documentation

Some subset of the sites that have undergone CERCLA PA/SIs have been scored using the Hazard Ranking System (HRS). Information on target populations and sensitive environments should be available for each of the routes scored. The most frequently scored routes are surface water and ground water. This document may identify potential locations of concern for the RFA, though it may not be comprehensive.

The Regional CERCLA program offices have copies of all CERCLA HRS reports and files.

3. CERCLA RI/FS Studies.

Again, some subset of the sites that have been given an HRS score will have been subject to a remedial investigation/feasibility study (RI/FS). If so, these reports will characterize in great detail: air, surface water, ground water and soil contamination, as well as populations actually or potentially affected by these releases.

The Regional CERCLA program offices have copies of all CERCLA RI/FS reports and files.

4. CERCLA 103(c) Notifications

Some sites may have information available on wastes disposed of at the facility from a CERCLA 103(c) notification, which provides information on all reportable quantities. In the early stages of the CERCLA program, owners or operators of waste management facilities and transporters were required to notify EPA of places where CERCLA hazardous substances had been disposed. EPA reviewed approximately 9000 notifications representing approximately 2000 sites, after accounting for redundant reporting. If the facility filed a CERCLA 103(c) notification, and no other source of information is available, this source may provide a record of past disposal operations, such as information on types, locations and volumes of waste disposed.

The reviewer should contact the Regional CERCLA coordinator to see if a CERCLA 103(c) notification exists for the facility.

III. Other Federal Environmental Program Sources

1. NPDES Permits and Permit Applications

The National Pollutant Discharge Elimination Program (NPDES) regulates the discharge of all pollutants into the waters of the United States. Many RCRA facilities also have NPDES permits for their wastewater discharges, and will have submitted permit applications and usually received permits. These permit applications may provide a large amount of detail on the types of waste generated at the facility, and some historical dats on how these wastes were disposed in the past.

The investigator should contact the Regional or State NPDES office in order to obtain copies of pertinent permits and/or permit applications.

2. Clean Air Act Permits and Permit Applications

Some RCRA facilities will have air emissions requiring stationary source controls under the Clean Air Act. These permits and permit applications may provide useful information on waste generation at the facility. The baghouse emission control dusts from some facilities (e.g., secondary lead smelting facilities) are listed hazardous wastes and must be disposed in accordance with RCRA. The Clean Air Act permits and permit applications should be consulted at the appropriate facilities.

The investigator should contact the Regional/State air permitting office for information on permitting at these facilities.

3. TSCA/OSHA Inspections

The Toxic Substances Control Act (TSCA) regulates the disposal of PCBs and PCB equipment. In some cases the responsibility for conducting TSCA inspections is merged with the RCRA inspection program. In other cases, these inspections are conducted by a different unit within EPA. TSCA inspection files may have useful data on how much and where disposal and storage of PCBs has taken place at a particular facility.

The Occupational Safety and Health Administration (OSHA) inspection reports may identify the types of materials handled by a facility and may also establish whether the owner or operator has a history of violations. Violation histories can indicate a facility's propensity for releases that might be subject to corrective action.

For information on TSCA activities at a facility, the investigator should contact the Regional toxic substances office. For information on OSHA inspections, the investigator should contact:

Occupational Safety and Health Administration, Federal Agency Programs
202-523-6027

4. Department of Defense Installation Restoration Program (IRP) Reports

The Department of Defense has been conducting a corrective action program at its facilities, entitled the Installation Restoration Program (IRP), for approximately ten years. This program was developed to characterize and remediate contamination at DOD facilities, and is similar to the Superfund program. The IRP program is organized into four phases: Phase I, which is similar to the RFA; Phase II, which is similar to a CERCLA Remedial Investigation; Phase III, which is similar to a CERCLA Feasibility Study; and Phase IV, which is the design/construct phase of the program.

All DOD facilities should have a completed Phase I report, which will be very useful during the RFA at these facilities. Many of the facilities will also have a completed Phase II report, which will also be of great use during the RFA. Each branch of the armed forces has a separate office coordinating their IRP work. The investigator should contact the following offices in order to obtain copies of IRP reports:

- U.S. Air Force: Occupational and Environmental Health Laboratory (OEHL)
- U.S. Army: U.S. Army Toxic and Hazardous Materials Agency (USATHMA)
- U.S. Navy: Naval Facilities Engineering Command (NavFEC)

IV. Other Miscellaneous Sources

1. Aerial Photography

Aerial photography, especially historical aerial photography, can be a valuable tool in a prelimary assessment. Historical aerial photography can provide the following types of information:

- The location of past disposal units;
- The location of releases;

- Evidence of existing or past vegetation stress;
- Potential routes for contamination migration;
- Location and numbers of target populations; and
- Land use in the area.

A number of RCRA sites that were evaluated under CERCLA have had both historical and recent aerial survey analysis. The RCRA reviewer should contact his/her regional coordinator for aerial photography. These coordinators have access through ORD/EMSL/LV to an index of sites that have had aerial photographic analyses.

If an historical analysis and current overflight do not exist, they can be requested through the regional coordinator. EMSL has a computerized system which accesses the major sources of extensive aerial photography including libraries, archives, and the U.S. Geologic Survey. EMSL can use this to order copies of the photographs, analyze the photographs for relevant features and prepare a bound copy of the analysis. In most cases, historical aerial photography will suffice for the purposes of the RCRA RFA.

The usefulness of current aerial photographs is more limited. They may be able to identify vestiges of old disposal practices, current vegetation damage, and surface drainage patterns. Infrared photographs may be useful in identifying areas of strained vegetation. They can also accurately locate target populations. However, much of this information may be readily ascertainable from a visual inspection of the facility. Accordingly, requests for overflights should be requested only when there are no other sources of the data.

2. State/local well permits

Most states require well drillers to obtain well installation permits. This source, if available, can provide the most reliable information on the number of households using well water in a particular area. These offices can often identify the aquifer from which individual wells draw and the construction of individual wells, including diameter. This information can also help in identifying the closest downgradient wells that have the appropriate well construction characteristics for sampling.

This information is usually kept on file in state environmental program offices, or may be found at county public works departments.

3. U.S. Geologic Survey and State Hydrogeologic Maps

The U.S. Geologic Survey (USGS) and state geologic surveys may have detailed maps characterizing the hydrogeology at locations of RCRA facilities. Many of these maps will supplement the ground-water characterization found in Part B applications, and for storage and treatment facilities, may provide the most available source of hydrogeologic information.

The USGS also has a series of geological atlases providing data on geology and soils. These maps can cover areas as small as one quadrangle (a 7.5 minute map), which is approximately 6 by 8 miles. These maps can also provide data on soils and rock types underlying facilities which may be helpful if data provided by the applicant are incomplete or unavailable. This may be especially useful for evaluating larger facilities.

USGS hydrological maps provide information on ground water yield, soil transmissivity and location of USGS wells (for monitoring water levels). This type of map may assist the reviewer in understanding the relationship between land based units and depth to ground water, location of ground water recharge areas, prevailing regional flow, and ground water discontinuities (if the owner or operator has not already provided this type of information). These maps are also available for areas as small as 7-1/2'.

These maps can be obtained by contacting the local USGS office, or in the case of state maps, the local state survey office.

4. U.S. Soil Conservation Service Soil Maps

U.S. Department of Agriculture Soil Conservation Service (SCS) offices map soil types and permeabilities at a resolution extending down to 2 acres in somes cases. These maps typically characterize soil type to a depth of six feet, and the backup information used to develop these maps may evaluate soils to greater depths. This backup information is also available through the local SCS.

5. GEMS (Graphical Exposure Modeling System)

EPA has access, through each of the regional offices, to a computerized system with the capability to identify the number of individuals within a specific radius of a facility. This system is readily available and can provide reliable information on populations potentially at risk from air releases. When coupled with data on ground use patterns, it can also quantify target populations drinking ground water.

6. Municipal/County/City Public Health Agencies

Municipal/county/city public health agencies or departments can provide a wealth of information on the types of units located at a particular facility and the wastes routinely received at the site. Fire marshalls can provide information on the nature of any fires or explosions that have occurred at the facility. Information on incidents and site management practices can assist in determining if any releases have occurred or are likely to occur as a result of poor facility management. These agencies maintain their records and files for a number of years and often provide the only other source of information on "old" units.

Even if these files contain little information, employees who have worked with the local agency or fire department for a number of years, often know a lot about the site or where to obtain additional information.

7. State/County Road Commissions

Core samples of soils and rocks underlying a proposed road are often analyzed during the engineering and planning stages of road construction. Records of these analyses are usually retained and available through most State/County road commissions. This information can provide useful data, where none or little are otherwise available, to evaluate the potential for contaminants to migrate through soils and ground water, and possibly to determine where to sample. This source will not be used routinely during the RFA.

8. Utilities

Utilities may be able to provide extremely reliable and up-to-date population data. They can identify the number of households using public water supplies, both ground water and surface water. They can also identify the location of public water wells and intakes. This information is necessary not only to determine the affected population but may also help identify possible locations for sampling. It will not usually be necessary to use this source during the RFA.

9. Local Airports/Weather Bureaus

2 These organizations maintain accurate historical records of the local climate. This information is essential in evaluating the potential and direction that contaminants could migrate through the air and the rate that contaminants could migrate through the ground water and surface water routes. Contaminants can be expected to migrate faster through the ground water in areas with higher precipitation. Wind direction(s) is essential in identifying downwind targets for air releases. Temperature is essential to evaluate the propensity for materials to volatilize. The amount of rainfall, especially during peak periods, can also indicate the likelihood that contaminants will migrate overland to surface water.

10. Naturalists/Environmental Organizations

Local environmental groups can provide information on the presence and location of wildlife and endangered species. They often have access to individuals or information which can identify the nesting grounds for animals. They can also identify any other sensitive environments.

11. Employees

Employees at the facility, both current and former, may be able to provide information on facility design and management as well as information on the types of wastes received at the facility. It may be difficult to obtain owner or operator permission to interview current employees. For former employees, it may be difficult to identify a knowledgable and reliable individual. When interviewing former and current employees, the investigator should be sure to understand the employee's motivation for providing the information and should find out why former employees no longer work at the facility.

12. Colleges/Universities

The biology departments of local colleges and universities may have information on the location of sensitive environments. In some cases, graduate student reports and publications have carefully mapped the location of nesting grounds and migratory pathways. Such studies can be valuable in identifying the impact of releases on target environments. The geology or agriculture departments of local colleges and universities may have information characterizing the local geology and hydrogeology. This can include maps of the area and studies evaluating the permeabilities of soils.

13. Interviews with Local Residents

As a last resort, local residents can be a source of information on a facility. Sometimes, long-term residents know a considerable amount about the kind of operations conducted at a facility and the type and amount of waste received at a facility. In general, this source of information should be avoided to prevent any undue or premature alarm.

14. Standard Reference Texts

Chemical Fate and Transport Information

1. U.S. EPA, Water-Related Environmental Fate of 129 Priority Pollutants, EPA-440/4-79-029a&b, 1979.
2. U.S. EPA, Aquatic Fate Process Data for Organic Priority Pollutants, EPA-440/4-81-014, December 1982.
3. Weast, R.C., ed., CRC Handbook of Chemistry and Physics, 61st ed., CRC Press, 1981.
4. ICF, Inc., Draft, Superfund Public Health Evaluation Manual, Prepared for U.S. EPA, Office of Emnergency and Remedial Response, December 18, 1985.

Ground-Water Hydrology and Monitoring Well Construction

1. Freeze, R. Allan, and John Cherry, Groundwater, Prentice-Hall, 1979.
2. U.S. EPA, Office of Waste Programs Enforcement, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, Draft, August, 1985.
3. Johnson Division, Groundwater and Wells, 2nd ed., 1986.

Hazardous Waste Site Characterization, Sampling, and Analysis

1. U.S. EPA, Environmental Monitoring Systems Laboratory, Characterization of Hazardous Waste Sites-A Methods Manual, Volume I-Site Investigations, Volume II, Available Sampling Methods, and Volume III, Available Laboratory Analytical Methods, EPA/600/4-84/075, April 1985.
2. U.S. EPA, Office of Emergency and Remedial Response, Guidance on Remedial Investigations Under CERCLA, May 1985.
3. U.S. EPA, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA SW-846, July 1982.
4. Standard Methods for the Examination of Water and Wastewater, 16th Ed., American Public Health Association, 1985.

Personal Safety

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values and Biological Exposure Indices for 1985-86, 1985.

2. National Institute of Occupational Safety and Health/Occupational Safety and Health Administration, NIOSH/OSHA Pocket Guide to Chemical Hazards, U.S. Government Printing Office.

3. U.S. EPA, Office of Emergency and Remedial Response, Standard Operating Safety Guides, Edison, NJ, 1984.

Toxicological Properties of Chemicals

1. Sax, Irving, ed., Dangerous Properties of Industrial Materials, 6th ed., Van Nostrand Reinhold, 1984.

2. National Institute of Occupational Safety and Health, Registry of Toxic Effects of Chemical Substances, U.S. Government Printing Office, (annual).

3. Clayton, G.D. and F.E. Clayton, Patty's Industrial Hygiene and Toxicology, 3rd ed.,Vols. 1-3, Wiley Interscience, 1979.

4. ICF, Inc., Draft, Superfund Public Health Evaluation Manual, Prepared for U.S. EPA, Office of Emergency and Remedial Response, December 18, 1985.

APPENDIX C

SAMPLE LETTER OF REQUEST FOR OWNER/OPERATOR INFORMATION

Dear Sirs:

As we have discussed in our recent telephone conversations, the _______ Plant has been selected by EPA as a subject for testing EPA's draft guidance, RCRA Facility Assessment Guidance. The preliminary assessment (PA) is the first phase in the process of determining whether solid waste management units (SWMU's) are releasing hazardous constituents to the environment and require corrective action.

After reviewing EPA files on the __________ Plant, a list of questions regarding additional information has been developed. It is anticipated that the requested information exists in your files. An attempt was made to keep the requested information to a minimum in order to avoid impacting your effort in preparing the Part B application.

The following information is requested:

1. Provide elevations of all SWMU units and/or identify the 100-year floodplain for the entire facility property.

2. Provide any available information (dates, quantities, materials, locations) on past spills in the production area.

3. Spill tanks are shown on Figure B-1 of _________ submittal, but are not mentioned in the text. Explain the purpose of the tanks and provide chemical information on the material stored in the tanks. If this unit does not fit the definition of a solid waste management unit, explain why.

4. For the New Trash Incinerator (Unit I.A.), indicate whether a permit has been issued by the _____________ Air Pollution Control Board. Provide a copy of the permit if it has been issued.

5. For the Waste Treatment Sludge Incinerator (Unit I.C.), provide the start-up date and planned closure date. Describe plans for treating or disposing of sludge after closure of the incinerator.

6. For the Waste Treatment unit (Unit 3), provide the following:

    i) A description of the modifications in plan operations which, when combined with amendments to the ________ hazardous waste regulations, have rendered the wastewater non-hazardous since November 1, 1983.

    ii) The start-up date for the original wastewater treatment unit (the "pre 7/82" unit), and any available description of wastewaster treatment and sludge disposal prior to the start-up of this unit.

    iii) Any available data concerning the hazardous constituents present in the sludge from the wastewater treatment plant unit prior to November 1, 1983.

7. For the Waste Recycling Operations (Unit 4), provide the following:

   i) A map showing the location of each recycling unit and associated storage tank and piping. The map should be on a scale of one-inch equal to not more than 200 feet.

   ii) An explanation of disposal and/or treatment of residues for each recycling unit.

8. Provide the exact locations of the land farm areas and delineate boundaries where possible. Clarify how many land farm areas have been used in the past.

9. Provide any available information on the chemical composition of the sludge that has been applied to the land farms in the past.

10. For the Storage Tanks (Unit 8), provide the following:

    i) A may showing the location of each tank and associated piping. The map should be on a scale of one-inch equal to not more than 200 feet. A map combining the Waste Recycling Operations (Unit 4), as requested above, with the storage tanks is acceptable.

    ii) For each tank, indicate if any secondary containment exists. A "yes" or "no" response will suffice.

    iii) Describe the leak test performed, frequency and date of last test for each tank.

    iv) For each tank identified as having been found to leak, provide any available information describing the approximate period of leakage and estimated volume of leaked wastes.

    v) For the tanks identified which may have been used in the past for solid waste storage, indicate which tanks are underground, elevated or at surface level.

11. Clarify how many landfills exist or have existed at the facility. Delineate boundaries of each landfill (where possible). If any other landfills are identified, describe what materials were disposed of in these landfills.

12. Provide any available information (dates, quantities, materials, locations) on past spills at the facility that were reported to the National Response Center (or the __________ Department of Health) as required under CERCLA.

APPENDIX D

GUIDANCE ON OBTAINING ACCESS TO A RCRA FACILITY IF ACCESS FOR A SITE INVESTIGATION IS DENIED

[SOURCE MATERIAL FROM: U.S.E.P.A. HAZARDOUS WASTE GROUND WATER TASK FORCE, "REVISED DRAFT PROTOCOL FOR GROUND-WATER INSPECTIONS AT HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES", JUNE 1985]

GUIDANCE ON OBTAINING ACCESS TO A RCRA FACILITY FOR A SITE INVESTIGATION IF ACCESS IS DENIED

If an investigator is denied access to a facility to conduct a site investigation, the following procedural steps must be followed.

Upon Denial of Access

1. Upon denial of access, thoroughly document the event, noting time, date, and facility personnel encountered. *
2. Ask for reason of denial of access to facility.
3. If the problem is beyond the investigator's authority, suggest that the owner/operator contact an attorney to obtain legal advice regarding his/her responsibility for providing facility access under Section 3007 of RCRA.
4. If entry is still denied, exit from the premises and document any observations made pertaining to the denial, particularly any suspicions of violations being covered up.
5. Report all aspects of denial of entry to the U.S. EPA Office of Regional Counsel for appropriate action, which may include help in obtaining a search warrant. **

Search Warrant Inspections

Conducting a site investigaton under a search warrant will differ from a normal inspection. The following procedures should be complied with in these situations:

Development of a Search Warrant

1. An EPA Office of Regional Counsel attorney will assist the investigator in the preparation of the documents necessary to obtain a search warrant and will arrange for a meeting with him/her and a U.S. Attorney. The investigator should bring a copy of the appropriate draft warrant and affadavits to the meeting.
2. The U.S. EPA Office of Regional Counsel attorney will inform the appropriate Headquarters Enforcement attorney of any denials of entry and send a copy of all papers filed to EPA Headquarters.
3. The attorney will then secure the warrant and forward it to the U.S. Marshall who will issue it to the owner/operator.

---

* Under no circumstances discuss potential penalties or do anything which may be construed as threatening.

** It should be stressed that it is the policy of U.S. EPA to obtain a warrant only when all other efforts to gain lawful entry have been exhausted.

Use of a Warrant to Gain Entry

1. The investigator should never attempt to make any forceful entry of the facility.

2. If there is a high probability that entry will be refused even with a warrant or where there are threats of violence, the investigator should be accompanied be a U.S. Marshall.

3. If entry is refused to an investigator holding a warrant but not accompanied by a U.S. Marshall, the investigator should leave the facility and inform the U.S. EPA Office of Regional Counsel.

Use of a Warrant to Conduct the Investigation

1. The investigation must be conducted strictly in accordance with the warrant. If the warrant restricts the investigation to certain areas of the premises or to certain records, those restrictions must be followed.

2. If sampling is authorized, all standard procedures must be carefully followed including presentation of receipts for all samples taken. The facility should also be informed of its right to retain a portion of the samples obtained by the investigator (split samples).

3. If records or property are authorized to be taken, the investigator must provide receipts to the owner/operator and maintain an inventory of all items removed from the premises.

4. In accordance with the warrant, the investigator should take photographs of all areas where violations are suspected. Photographs should also be taken at each sampling location as a quality control procedure.

For further guidance regarding denial of facility access consult the National Enforcement Investigation Center. (303) 236-5100

APPENDIX E

PHYSICAL AND CHEMICAL PARAMETERS FOR CONSTITUENTS OF CONCERN

[THE ATTACHED WAS PREPARED BY ICF, INC., FOR THE OFFICE OF EMERGENCY AND REMEDIAL RESPONSE, EPA, AND FOUND IN "DRAFT SUPERFUND HEALTH ASSESSMENT MANUAL", MAY 1985]

Date Prepared: December 18, 1985

EXHIBIT C-1

PHYSICAL, CHEMICAL, AND FATE DATA

Chemical Name	CAS #	Mole Weight (g/mole)	Water Solubility (mg/l)	S*	Vapor Pressure (mm Hg)	S*	Henry's Law Constant (atm-m3/mol)	Koc (ml/g)	S*	log Kow	S*	Fish BCF (l/kg)	S*
Acenaphthene	83-32-9	154	3.42E+00	C	1.55E-03	C	9.20E-05	4600	C	4.00	C	242	H
Acenaphthylene	208-96-8	152	3.93E+00	C	2.90E-02	C	1.48E-03	2500	C	3.70	C		
Acetone	67-64-1	58	1.00E+06	#	2.70E+02	J	2.06E-05	2.2	&	-0.24	J		
Acetonitrile	75-05-8	41	1.00E+06	#	7.40E+01	F	4.00E-06	2.2	&	-0.34	I		
2-Acetylaminofluorene	53-96-3	223	6.50E+00	B			NA	1600	&	3.28	B		
Acrylic Acid	79-10-7	72	1.00E+06	#	4.00E+00	F				0.13	I	0	I
Acrylonitrile	107-13-1	53	7.90E+04	C	1.00E+02	C	8.84E-05	0.85	C	0.25	C	48	G
Aflatoxin B1	1162-65-8	312					NA						
Aldrin	309-00-2	365	1.80E-01	C	6.00E-06	C	1.60E-05	96000	C	5.30	C	28	H
Allyl Alcohol	107-18-6	58	5.10E+05	B	2.46E+01	B	3.69E-06	3.2	&	-0.22	B		
Aluminum Phosphide	20859-73-8	58											
4-Aminobiphenyl	92-67-1	169	8.42E+02	B	6.00E-05	B	1.59E-08	107	&	2.78	B		
Amitrole	61-82-5	84	2.80E+05	B			NA	4.4	&	-2.08	B		
Ammonia	7664-41-7	17	5.30E+05	I	7.60E+03	F	3.21E-04	3.1	&	0.00	I	0	I
Anthracene	120-12-7	178	4.50E-02	A	1.95E-04	A	1.02E-03	14000	C	4.45	A		
Antimony and Compounds	7440-36-0	122			1.00E+00	N	NA					1	H
Arsenic and Compounds	7440-38-2	75			0.00E+00	F	NA					44	H
Asbestos	1332-21-4	NA	NA		NA		NA	NA		NA		0	D
Auramine	2465-27-2	267	2.10E+00	B			NA	2900	&	4.16	B		
Azaserine	115-02-6	173	1.36E+05	B			NA	6.6	&	-1.08	B		
Aziridine	151-56-4	43	2.66E+06	B	2.55E+02	B	5.43E-06	1.3	&	-1.01			
Barium and Compounds	7440-39-3	137					NA						
Benzene	71-43-2	78	1.75E+03	A	9.52E+01	A	5.59E-03	83	G	2.12	A	5.2	H
Benzidine	92-87-5	184	4.00E+02	C	5.00E-04	C	3.03E-07	10.5	C	1.30	C	87.5	H
Benz(a)anthracene	56-55-3	228	5.70E-03	C	2.20E-08	O	1.16E-06	1380000	G	5.60	C		
Benz(c)acridine	225-51-4	229	1.40E+01	B			NA	1000	&	4.56	B		
Benzo(a)pyrene	50-32-8	252	1.20E-03	A	5.60E-09	A	1.55E-06	5500000	C	6.06	C		
Benzo(b)fluoranthene	205-99-2	252	1.40E-02	C	5.00E-07	C	1.19E-05	550000	C	6.06	A		
Benzo(ghi)perylene	191-24-2	276	7.00E-04	A	1.03E-10	A	5.34E-08	1600000	C	6.51	A		
Benzo(k)fluoranthene	207-08-9	252	4.30E-03	C	5.10E-07	C	3.94E-05	550000	C	6.06	C		
Benzyl Chloride	100-44-7	127	3.30E+03	F	1.00E+00	E	5.06E-05	50	&	2.63	F		
Beryllium and Compounds	7440-41-7	9			0.00E+00	L	NA					19	H
Bis(2-chloroethyl)ether	111-44-4	143	1.02E+04	C	7.10E-01	C	1.31E-05	13.9	C	1.50	C	6.9	H
Bis(2-chloroisopropyl)ether	108-60-1	171	1.70E+03	C	8.50E-01	C	1.13E-04	61	C	2.10	C	0	D
Bis(chloromethyl)ether	542-88-1	115	2.20E+04	C	3.00E+01	C	2.06E-04	1.2	C	0.38	C	0.63	H
1,3-Butadiene	106-99-0	54	7.35E+02	I	1.84E+03	F	1.78E-01	120	&	1.99	F		
Cacodylic Acid	75-60-5	138	8.30E+05	I			NA	2.4	&	0.00	I		
Cadmium and Compounds	7440-43-9	112			0.00E+00	F	NA					81	H
Captan	133-06-2	301	5.00E-01	I	6.00E-05	I	4.75E-05	6400	&	2.35	F		
Carbaryl	63-25-2	201	4.00E+01	I	5.00E-03	E				2.36	F		
Carbon Disulfide	75-15-0	76	2.94E+03	I	3.60E+02	L	1.23E-02	54	&	2.00	I	0	I
Carbon Tetrachloride	56-23-5	154	7.57E+02	A	9.00E+01	A	2.41E-02	110	&	2.64	A	19	H
Chlordane	57-74-9	410	5.60E-01	A	1.00E-05	A	9.61E-06	140000	C	3.32	A	14000	H
Chlorobenzene	108-90-7	113	4.66E+02	A	1.17E+01	A	3.72E-03	310	C	2.84	A	10	H
Chlorobenzilate	510-15-6	325	2.19E+01	B	1.20E-06	B	2.34E-08	800	&	4.51	B		
Chlorodibromomethane	124-48-1	208			1.50E+01	D	NA			2.09	D		
Chloroform	67-66-3	119	8.20E+03	A	1.51E+02	A	2.87E-03	31	&	1.97	A	3.75	H
Chloromethyl Methyl Ether	107-30-2	81					NA			0.00	I		
4-Chloro-o-toluidine Hydrochloride	3165-93-3	142					NA						
Chromium III and Compounds	7440-47-3	52			0.00E+00	E	NA					16	H
Chromium VI and Compounds	7440-47-3	52			0.00E+00	E	NA					16	H
Chrysene	218-01-9	228	1.80E-03	A	6.30E-09	A	1.05E-06	200000	C	5.61	A		
Copper and Compounds	7440-50-8	64			0.00E+00	G	NA					200	D
Creosote	8001-58-9	NA					NA						
Cresol	1319-77-3	108	3.10E+04	I	2.40E-01	J	1.10E-06	500	G	1.97	F	0	I

Date Prepared: December 18, 1985

EXHIBIT C-1
(Continued)

PHYSICAL, CHEMICAL, AND FATE DATA

Chemical Name	CAS #	Mole Weight (g/mole)	Water Solubility (mg/l)	S*	Vapor Pressure (mm Hg)	S*	Henry's Law Constant (atm-m3/mol)	Koc (ml/g)	S*	log Kow	S*	Fish BCF (l/kg)	S*
Cyanides	57-12-5	NA					NA						
-- Barium Cyanide	542-62-1	189											
-- Calcium Cyanide	592-01-8	92											
-- Copper Cyanide	544-92-3	90											
-- Cyanogen	460-19-5	52	2.50E+05	K									
-- Cyanogen Chloride	506-77-4	61	2.50E+03	I	1.00E+01	J				0.00	I		
-- Hydrogen Cyanide	74-90-8	27	1.00E+06	#	6.20E+02	L				-0.25	I	0	I
-- Nickel Cyanide	557-19-7	182											
-- Potassium Cyanide	151-50-8	65	5.00E+05	K									
-- Potassium Silver Cyanide	506-61-6	199											
-- Silver Cyanide	506-64-9	134											
-- Sodium Cyanide	143-33-9	49	8.20E+05	H									
-- Zinc Cyanide	557-21-1	117											
Cyclophosphamide	50-18-0	261	1.31E+09	B			NA	0.042	&	-3.22	B		
DDD	72-54-8	320	1.00E-01	C	1.89E-06	C	7.96E-06	770000	C	6.20	C		
DDE	72-55-9	318	4.00E-02	C	6.50E-06	C	6.80E-05	4400000	C	7.00	C	51000	G
DDT	50-29-3	355	5.00E-03	A	5.50E-06	A	5.13E-04	243000	G	6.19	J	54000	H
Diallate	2303-16-4	274	1.40E+01	B	6.40E-03	B	1.65E-04	1000	&	0.73	B		
2,4-Diaminotoluene	95-80-7	122	4.77E+04	B	3.80E-05	B	1.28E-10	12	&	0.35	B		
1,2,7,8-Dibenzopyrene	189-55-9	305	1.10E-01	B			NA	1200	&	6.62	B		
Dibenzo(a,h)anthracene	53-70-3	278	5.00E-04	C	1.00E-10	C	7.33E-08	3300000	C	6.80	C		
1,2-Dibromo-3-chloropropane	96-12-8	236	1.00E+03	B	1.00E+00	B	3.11E-04	98	&	2.29	B		
Dibutylnitrosamine	924-16-3	152					NA						
Dibutyl Phthalate	84-74-2	278	1.30E+01	C	1.00E-05	C	2.82E-07	170000	C	5.60	C		
1,2-Dichlorobenzene	95-50-1	147	1.00E+02	C	1.00E+00	C	1.93E-03	1700	C	3.60	C	56	H
1,3-Dichlorobenzene	541-73-1	147	1.23E+02	C	2.28E+00	C	3.59E-03	1700	C	3.60	C	56	H
1,4-Dichlorobenzene	106-46-7	147	7.90E+01	C	1.18E+00	C	2.89E-03	1700	C	3.60	C	56	H
3,3'-Dichlorobenzidine	91-94-1	253	4.00E+00	C	1.00E-05	C	8.33E-07	1553	C	3.50	C	312	H
Dichlorodifluoromethane	75-71-8	121	2.80E+02	C	4.87E+03			58	C	2.16	D		
1,1-Dichloroethane	75-34-3	99	5.50E+03	A	1.82E+02	A	4.31E-03	30	C	1.79	A		
1,2-Dichloroethane (EDC)	107-06-2	99	8.52E+03	A	6.40E+01	A	9.78E-04	14	C	1.48	A	1.2	H
1,1-Dichloroethylene	75-35-4	97	2.25E+03	A	6.00E+02	A	3.40E-02	65	C	1.84	A	5.6	H
1,2-Dichloroethylene (trans)	540-59-0	97	6.30E+03	A	3.24E+02	A	6.56E-03	59	C	0.48	A	1.6	H
1,2-Dichloroethylene (cis)	540-59-0	97	3.50E+03	A	2.08E+02	A	7.58E-03	49	&	0.70	A	1.6	H
Dichloromethane	75-09-2	85	2.00E+04	C	3.62E+02	C	2.03E-03	8.8	C	1.30	C	5	H
2,4-Dichlorophenol	120-83-2	163	4.60E+03	C	5.90E-02	C	2.75E-06	380	C	2.90	C	41	H
2,4-Dichlorophenoxyacetic Acid (2,4-D)	94-75-7	221	6.20E+02	F	4.00E-01	F	1.88E-04	20	G	2.81	F		
4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	94-82-6												
Dichlorophenylarsine	696-28-6	223					NA						
1,2-Dichloropropane	78-87-5	113	2.70E+03	C	4.20E+01	C	2.31E-03	51	C	2.00	C		
1,3-Dichloropropene	542-75-6	111	2.80E+03	C	2.50E+01	C	1.30E-03	48	C	2.00	C	1.9	H
Dieldrin	60-57-1	381	1.95E-01	C	1.78E-07	C	4.58E-07	1700	C	3.50	C	4760	H
Diepoxybutane	1464-53-5	86					NA						
Diethanolnitrosamine	1116-54-7	134					NA						
Diethyl Arsine	692-42-2	134	4.17E+02	B	3.50E+01	B	1.48E-02	160	&	2.97	B		
1,2-Diethylhydrazine	1615-80-1	88	2.88E+07	B			NA	0.3	&	-1.68	H		
Diethylnitrosamine	55-18-5	102			5.00E+00	I	NA			0.48	I		
Diethyl Phthalate	84-66-2	222	8.96E+02	C	3.50E-03	C	1.14E-06	142	C	2.50	C	117	G
Diethylstilbestrol (DES)	56-53-1	268	9.60E-03	B			NA	28	&	5.46	B		
Dihydrosafrole	94-58-6	164	1.50E+03	B			NA	78	&	2.56	B		
Dimethoate	60-51-5	229	2.50E+04	J	2.50E-02	J				2.71	J		
3,3'-Dimethoxybenzidine	119-90-4	244					NA						
Dimethylamine	124-40-3	45	1.00E+06	I	1.52E+03	I	9.02E-05	2.2	&	-0.38	I	0	I
Dimethyl Sulfate	77-78-1	126	3.24E+05	B	6.80E-01	B	3.48E-07	4.1	&	-1.24	B		

Date Prepared: December 18, 1985

EXHIBIT C-1
(Continued)

PHYSICAL, CHEMICAL, AND FATE DATA

Chemical Name	CAS #	Mole Weight (g/mole)	Water Solubility (mg/l)	S*	Vapor Pressure (mm Hg)	S*	Henry's Law Constant (atm-m3/mol)	Koc (ml/g)	S*	log Kow	S*	Fish BCF (l/kg)	S*
Dimethylaminoazobenzene	60-11-7	225	1.36E+01	B	1.30E-07	B	7.19E-09	1000	&	3.72	B		
7,12-Dimethylbenz(a)anthracene	57-97-6	256	4.40E-03	B			NA	476000	G	6.94	B		
Dimethylcarbamoyl Chloride	79-44-7	108	1.44E+07	B	1.95E+00	B	1.92E-08	0.5	&	-1.32	B		
1,1-Dimethylhydrazine	57-14-4	60	1.24E+08	B	1.57E+02	B	1.00E-07	0.2	&	-2.42	B		
1,2-Dimethylhydrazine	540-73-8	60					NA						
Dimethylnitrosamine	62-75-9	74	1.00E+06	#	8.10E+00	C	7.90E-07	0.1	C	-0.68	C	0	D
1,3-Dinitrobenzene	99-65-0	168	4.70E+02	J			NA	150	&	1.62	F		
4,6-Dinitro-o-cresol	534-52-1	198	2.90E+02	C	5.00E-02	C	4.49E-05	240	C	2.70	C	0	I
2,4-Dinitrophenol	51-28-5	184	5.60E+03	C	1.49E-05	C	6.45E-10	16.6	C	1.50	C	0	D
2,3-Dinitrotoluene	602-01-7	182	3.10E+03	B			NA	53	&	2.29	B	3.8	H
2,4-Dinitrotoluene	121-14-2	182	2.40E+02	C	5.10E-03	C	5.09E-06	45	C	2.00	C	3.8	H
2,5-Dinitrotoluene	619-15-8	182	1.32E+03	B			NA	84	&	2.28	B	3.8	H
2,6-Dinitrotoluene	606-20-2	182	1.32E+03	B	1.80E-02	C	3.27E-06	92	C	2.00	C	3.8	H
3,4-Dinitrotoluene	610-39-9	182	1.08E+03	B			NA	94	&	2.29	B	3.8	H
Dinoseb	88-85-7	240	5.00E+01	J									
1,4-Dioxane	123-91-1	88	4.31E+05	B	3.99E+01	B	1.07E-05	3.5	&	0.01	B		
N,N-Diphenylamine	122-39-4	169	5.76E+01	B	3.80E-05	B	1.47E-07	470	&	3.60	B	30	G
1,2-Diphenylhydrazine	122-66-7	184	1.84E+03	C	2.60E-05	C	3.42E-09	418	C	2.90	C	25	H
Dipropylnitrosamine	621-64-7	130	9.90E+03	C	4.00E-01	C	6.92E-06	15	C	1.50	C		
Epichlorohydrin	106-89-8	93	6.00E+04	J	1.57E+01	B	3.19E-05	10	&	0.15	B		
Ethanol	64-17-5	46	1.00E+06	#	7.40E+02	G	4.48E-05	2.2	&	-0.32	J		
Ethyl Methanesulfonate	62-50-0	124	3.69E+05	B	2.06E-01	B	9.12E-08	3.8	&	0.21	B		
Ethylbenzene	100-41-4	106	1.52E+02	A	7.00E+00	A	6.43E-03	1100	C	3.15	A	37.5	H
Ethylene Dibromide (EDB)	106-93-4	188	4.30E+03	J	1.17E+01	B	6.73E-04	44	G	1.76	B		
Ethylene Oxide	75-21-8	44	1.00E+06	B	1.31E+03	B	7.56E-05	2.2	&	-0.22	B		
Ethylenethiourea	96-45-7	102	2.00E+03	F			NA	67	&	-0.66	J	0	F
1-Ethyl-nitrosourea	759-73-9	117	3.31E+08	B			NA	0.1	&				
Ferric Dextran	9004-66-4	7500					NA						
Fluoranthene	206-44-0	202	2.06E-01	A	5.00E-06	A	6.46E-06	38000	C	4.90	A	1150	H
Fluorene	86-73-7	116	1.69E+00	C	7.10E-04	C	6.42E-05	7300	C	4.20	C	1300	G
Fluorides	7782-41-4	NA					NA						
Formaldehyde	50-00-0	30	4.00E+05	K	1.00E+01	E	9.87E-07	3.6	&	0.00	F	0	F
Formic Acid	64-18-6	46	1.00E+06		4.00E+01	F				-0.54	F	0	F
Glycidaldehyde	765-34-4	72	1.70E+08	B	1.97E+01	B	1.10E-08	0.1	&	-1.55	B		
Glycol Ethers	NA	NA					NA						
-- Diethylene Glycol, Monoethyl Ether	111-90-0	134											
-- 2-Ethoxyethanol	110-80-5	90	1.00E+06	F						0.00	F		
-- Ethylene Glycol, Monobutyl Ether	111-76-2	118	1.00E+06	F						0.00	F		
-- 2-Methoxyethanol	109-86-4	76	1.00E+06	K									
-- Propylene Glycol, Monoethyl Ether	52125-53-8												
-- Propylene Glycol, Monomethyl Ether	107-98-2												
Heptachlor	76-44-8	374	1.80E-01	C	3.00E-04	C	8.19E-04	12000	C	4.40	C	15700	H
Heptachlor Epoxide	1024-57-3	389	3.50E-01	C	3.00E-04	C	4.39E-04	220	C	2.70	C	14400	G
Hexachlorobenzene	118-74-1	285	6.00E-03	A	1.09E-05	A	6.81E-04	3900	G	5.23	A	8690	H
Hexachlorobutadiene	87-68-3	261	1.50E-01	A	2.00E+00	A	4.57E+00	29000	C	4.78	A	2.8	H
Hexachlorocyclopentadiene	77-47-4	273	2.10E+00	A	8.00E-02	A	1.37E-02	4800	C	5.04	A	4.3	H
alpha-Hexachlorocyclohexane (HCCH)	319-84-6	291	1.63E+00	C	2.50E-05	C	5.87E-06	3800	C	3.90	C	130	H
beta-HCCH	319-85-7	291	2.40E-01	C	2.80E-07	C	4.47E-07	3800	C	3.90	C	130	H
gamma-HCCH (Lindane)	58-89-9	291	7.80E+00	C	1.60E-04	C	7.85E-06	1080	G	3.90	C	130	H
delta-HCCH	319-86-8	291	3.14E+01	C	1.70E-05	C	2.07E-07	6600	C	4.10	C	130	H
Hexachloroethane	67-72-1	237	5.00E+01	C	4.00E-01	C	2.49E-03	20000	C	4.60	C	87	H
Hexachlorophene	70-30-4	407	4.00E-03	F			NA	91000	&	7.54	F		

Date Prepared: December 10, 1985

EXHIBIT C-1
(Continued)

PHYSICAL, CHEMICAL, AND FATE DATA

Chemical Name	CAS #	Mole Weight (g/mole)	Water Solubility (mg/l)	S*	Vapor Pressure (mm Hg)	S*	Henry's Law Constant (atm-m3/mol)	Koc (ml/g)	S*	log Kow	S*	Fish BCF (l/kg)	S*
Hydrazine	302-01-1	32	3.41E+08	B	1.40E+01	B	1.73E-09	0.1	&	-3.08	B		
Hydrogen Sulfide	7783-06-4	34	4.13E+03	K									
Indeno(1,2,3-cd)pyrene	193-39-5	276	5.30E-04	C	1.00E-10	C	6.86E-08	1600000	C	6.50	C		
Iodomethane	77-88-4	142	1.40E+04	J	4.00E+02	J	5.34E-03	23	&	1.69	J		
Iron and Compounds	15438-31-0	56					NA						
Isoprene	78-79-5	68			4.00E+02	E	NA						
Isosafrole	120-58-1	168	1.09E+03	B	1.60E-08	B	3.25E-12	93	&	2.66	B		
Kepone	143-50-0	491	9.90E-03	B			NA	55000	&	2.00	B	8400	G
Lasiocarpine	303-34-4	412	1.60E+03	B			NA	76	&	0.99	B		
Lead and Compounds (Inorganic)	7439-92-1	207			0.00E+00	E	NA					49	H
Linuron	330-55-2												
Malathion	121-75-7	330	1.45E+02	L	4.00E-05	L				2.89	J	0	F
Manganese and Compounds	7439-96-5	55					NA						
Mercury and Compounds (Alkyl)	7439-97-6						NA					3750	H
Mercury and Compounds (Inorganic)	7439-97-6	201			2.00E-03	E	NA					5500	H
Mercury Fulminate	628-86-4												
Methyl Chloride	74-87-3	50	6.50E+03	C	4.31E+03	B	4.40E-02	35	&	0.95	B		
Methyl Ethyl Ketone	78-93-3	72	2.68E+05	A	7.75E+01	A	2.74E-05	4.5	&	0.26	A	0	F
Methyl Ethyl Ketone Peroxide	1338-23-4												
Methyl Methacrylate	80-62-6	100	2.00E+01	F	3.70E+01	E	2.43E-01	840	&	0.79	F		
Methyl Parathion	298-00-0	263	6.00E+01	L	9.70E-06	L	5.59E-08	460	&	1.91	F	45	I
2-Methyl-4-chlorophenoxyacetic Acid	94-74-6	201											
3-Methylcholanthrene	56-49-3	268					NA						
4,4'-Methylene-bis-2-chloroaniline	101-14-4	267					NA						
Methylnitrosourea	684-93-5	103	6.89E+08	B			NA	0.1	&	-3.81	B		
Methylthiouracil	56-04-2	142					NA						
Methylvinylnitrosamine	4549-40-0	86	7.60E+05	B	1.23E+01	B	1.83E-06	2.5	&	-0.23	B		
N-Methyl-N'-nitro-N-nitrosoguanadin	70-25-7						NA						
Mitomycin C	50-07-7	334					NA						
Mustard Gas	505-60-2	159	8.00E+02	B	1.70E-01	B	4.45E-05	110	&	1.37	B		
1-Napthylamine	134-32-7	143	2.35E+03	B	6.50E-05	B	5.21E-09	61	&	2.07	B		
2-Napthylamine	91-59-8	143	5.86E+02	B	2.56E-04	B	8.23E-08	130	&	2.07	B		
Nickel and Compounds	7440-02-0	59			0.00E+00	D	NA					47	H
Nitric Oxide	10102-43-9	30											
Nitrobenzene	98-95-3	123	1.90E+03	C	1.50E-01	B		36	C	1.85	D		
Nitrogen Dioxide	10102-44-0	46											
Nitrosomethylurethane	615-53-2						NA						
N-Nitrosopiperidine	100-75-4	114	1.90E+06	B	1.40E-01	B	1.11E-08	1.5	&	-0.49	B		
N-Nitrosopyrrolidine	930-55-2	100	7.00E+06	B	1.10E-01	B	2.07E-09	0.8	&	-1.06	B		
5-Nitro-o-toluidine	99-55-8						NA						
Pentachlorobenzene	608-93-5	250	1.35E-01	F			NA	13000	&	5.19	F	2125	H
Pentachloronitrobenzene	82-68-8	295	7.11E-02	B	1.13E-04	B	6.18E-04	19000	&	5.45	B		
Pentachlorophenol	87-86-5	266	1.40E+01	C	1.10E-04	C	2.75E-06	53000	C	5	C	770	G
Phenacetin	62-44-2	179					NA						
Phenanthrene	85-01-8	178	1.00E+00	A	6.80E-04	A	1.59E-04	14000	C	4.46	A	2630	G
Phenobarbital	50-06-6	232	1.00E+03	B			NA	98	&	-0.19	B		
Phenol	108-95-2	94	9.30E+04	A	3.41E-01	A	4.54E-07	14.2	C	1.46	A	1.4	H
Phenyl Mercuric Acetate	62-38-4	337	1.67E+03	K									
Phosphine	7803-51-2	34											
Phenylalanine Mustard	148-82-3	305					NA						
Polychlorinated Biphenyls (PCBs)	1336-36-3	328	3.10E-02	C	7.70E-05	C	1.07E-03	530000	C	6.04	C	100000	G
Propane Sultone	1120-71-4						NA						
Propylenimine	75-55-8	57	9.44E+05	B	1.41E+02	B	1.12E-05	2.3	&	-0.48	B		
Pyrene	129-00-0	202	1.32E-01	A	2.50E-06	A	5.04E-06	38000	C	4.88	A		
Pyridine	110-86-1	79	1.00E+06	I	2.00E+01	I				0.66	I		
Saccharin	81-07-2	183					NA						

Date Prepared: December 18, 1985

EXHIBIT C-1
(Continued)

PHYSICAL, CHEMICAL, AND FATE DATA

Chemical Name	CAS #	Mole Weight (g/mole)	Water Solubility (mg/l)	S*	Vapor Pressure (mm Hg)	S*	Henry's Law Constant (atm-m3/mol)	Koc (ml/g)	S*	log Kow	S*	Fish BCF (l/kg)	S*
Safrole	94-59-7	162	1.50E+03	B	9.10E-04	B	1.29E-07	78	&	2.53	B		
Selenium and Compounds	7782-49-2	79			0.00E+00	E	NA					16	H
-- Selenious Acid	7783-00-8	129											
-- Selenourea	630-10-4												
-- Thallium Selenite	12039-52-0	488											
Silver and Compounds	7440-22-4	108			0.00E+00	D	NA					3080	D
Streptozocin	18883-66-4	457					NA						
Strychnine	57-24-9	334	1.56E+02	E									
1,2,4,5-Tetrachlorobenzene	95-94-3	216	6.00E+00	F			NA	1600	&	4.67	I	1125	H
2,3,7,8-TCDD (Dioxin)	1746-01-6	322	2.00E-04	A	1.70E-06	A	3.60E-03	3300000	C	6.72	A	5000	H
1,1,1,2-Tetrachloroethane	630-20-6	168	2.90E+03	J	5.00E+00	J	3.81E-04	54	&				
1,1,2,2-Tetrachloroethane	79-34-5	168	2.90E+03	A	5.00E+00	A	3.81E-04	118	C	2.39	A	42	H
Tetrachloroethylene	127-18-4	166	1.50E+02	A	1.78E+01	A	2.59E-02	364	C	2.6	A	31	H
2,3,4,6-Tetrachlorophenol	58-90-2	142	1.00E+03	F			NA	98	&	4.1	F	240	H
Tetraethyl Lead	78-00-2	323	8.00E-01	J	1.50E-01	J	7.97E-02	4900	&				
Thallium and Compounds	7440-28-0	204			0.00E+00	E							
-- Thallium Acetate	563-68-8	263											
-- Thallium Carbonate	6533-73-9	469											
-- Thallium Chloride	7791-12-0	240	2.90E+03	F	0.00E+00	I							
-- Thallium Nitrate	10102-45-1												
-- Thallic Oxide	1314-32-5												
-- Thallium Sulfate	7446-18-6	505	2.00E+02	E	0.00E+00	I							
Thioacetamide	62-55-5	75					NA			-0.46	J		
Thiourea	62-56-6	76	1.72E+06	B			NA	1.6	&	-2.05	B		
o-Tolidine	119-93-7	212	7.35E+01	B			NA	410	&	2.88	B		
Toluene	108-88-3	92	5.35E+02	A	2.81E+01	A	6.37E-03	300	C	2.73	A	10.7	H
o-Toluidine	636-21-5	107	1.50E+04	J	1.00E-01	J	9.39E-07	22	&	1.29	J		
Toxaphene	8001-35-2	414	5.00E-01	C	4.00E-01	C	4.36E-01	964	C	3.3	C	13100	H
Tribromomethane (Bromoform)	75-25-2	253	3.01E+03	C	5.00E+00	C	5.52E-04	116	C	2.4	C		
1,2,4-Trichlorobenzene	120-82-1	181	3.00E+01	C	2.90E-01	C	2.31E-03	9200	C	4.3	C	2800	G
1,1,1-Trichloroethane	71-55-6	133	1.50E+03	A	1.23E+02	A	1.44E-02	152	C	2.5	C	5.6	H
1,1,2-Trichloroethane	79-00-5	133	4.50E+03	A	3.00E+01	A	1.17E-03	56	C	2.47	A	5	H
Trichloroethylene	79-01-6	131	1.10E+03	A	5.79E+01	A	9.10E-03	126	C	2.38	A	10.6	H
Trichlorfon	52-68-6	257	1.54E+05	I	7.80E-06	E	1.71E-11	6.1	&	2.29	A		
Trichloromonofluoromethane	75-69-4	137	1.10E+03	C	6.67E+02	C		159	C	2.53	D		
2,4,5-Trichlorophenol	95-95-4	197	1.19E+03	A	1.00E+00	A	2.18E-04	89	&	3.72	A	110	H
2,4,6-Trichlorophenol	88-06-2	198	8.00E+02	A	1.20E-02	A	3.90E-06	2000	C	3.87	A	150	H
1,1,2-Trichloro-1,2,2,-trifluoroethane	76-13-1	187	1.00E+01	F	2.70E+02	I				2.00	F		
Tris(2,3-dibromopropyl)phosphate	126-72-7	698	1.20E+02	B			NA	310	&	4.12	B	2.7	G
Trypan Blue	72-57-1	961					NA						
Uracil Mustard	66-75-1	252	6.41E+02	B			NA	120	&	-1.09	B		
Uranium and Compounds	7440-61-1	238					NA						
Urethane	51-79-6	89					NA						
Vanadium and Compounds	7440-62-2	51					NA						
Vinyl Chloride	75-01-4	63	2.67E+03	A	2.66E+03	A	8.19E-02	57	&	1.38	A	1.17	H
o-Xylene	95-47-6	106	1.75E+02	F	1.00E+01	I				2.95	I		
m-Xylene	108-38-3	106	1.30E+02	F	1.00E+01	I				3.26	I		
p-Xylene	106-42-3	106	1.98E+02	I	1.00E+01	I				3.15	I		
Xylene (mixed)	1330-20-7	106	1.98E+02	I	1.00E+01	I	7.04E-03	240	&	3.26	F		
Zinc and Compounds	7440-66-6	65			0.00E+00	D	NA					47	H

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* Letters denote the source of the data, as listed in Section 3.1.
# Solubility of 1,000,000 mg/l assigned because of reported "infinite solubility" in the literature.
& Koc estimated by the following equation: log Koc = (-0.55*logS) + 3.64 [Note: S in mg/l].

APPENDIX F

EXAMPLE DATA ELEMENTS FOR FACILITY PRIORITIZATION

APPENDIX F

EXAMPLE DATA ELEMENTS FOR FACILITY PRIORITIZATION

1. What is the net recharge of the facility area?

2. What is the distance from the unit to the aquifer below the unit? If actual depth is unknown, circle closest approximation of depth from ranges given below:

   Feet: 0-5 5-10 10-30 30-50 50-75 75-100 100+

3. What is the slope of the surface topography within the facility boundary? Circle closest approximation of slope from ranges given below:

   % Slope: 0-2 2-6 6-12 12-18 18+

4. How deep is the soil layer beneath the facility? (Use soil references cited in RFI guidance.)

5. Is there a surface water body downgradient that is within two miles of the unit?

   If yes, what is the distance betwen the surface water body and the unit?

6. For land disposal facilities (that should have information on hydraulic conductivity, hydraulic gradient, and effective porosity included in their Part B permit applications), calculate the time of travel (TOT) to the facility boundary and the nearest drinking water well downgradient. Refer to:

   Criteria for Identifying Areas of Vulnerable Hydrogeology - Interim Final, June 1985: the time of travel calculation was developed by the U.S. EPA Office of Solid Waste as a tool to be used in assessing the vulnerability of ground water in different hydrogeologic settings.

   The following steps should be completed when calculating TOT:

   a) What is the calculated or average velocity (V) of ground-water flow below the facility? (Refer to criteria cited above.)

b) What is the distance to:

   1) facility boundary?
   2) nearest downgradient drinking water well(s)?

   What is the TOT for:

   1) time to facility boundary?
   2) time to nearest downgradient drinking water well(s)? (Refer to Criteria cited above.)

7. For facilities other than land disposal facilities, facilities located on karst terrain or fractured bedrock:

   If a rapid ground water velocity is suspected, collect data on hydraulic gradient, hydraulic conductivity, and effective porosity in order to calculate TOT from the unit to 1) facility boundary and 2) nearest drinking water well.

8. What is/are the waste constituent(s) of concern? If unknown, provide available information on the following aspects of the waste to allow reasonable inferences to be drawn on what constituents are present.

   a) Suspected classes of compounds (e.g., organic solvents, inorganics, etc.);

   b) Waste streams (e.g., pickle liquor);

   c) Manufacturing process(es) which produced waste.

9. Are there any active production wells near the unit or facility? If yes:

   a) What is the distance between the unit and the production well(s)?

   b) What is the production capacity of the well(s)?

   c) How old is the unit(s)?